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TECHNICAL MANUAL

INSTRUCTIONS AND PARTS BREAKDOWN

AC-DC DIFFERENTIAL VOLTMETER

MODEL 803

SERIAL NO. 9000 AND ABOVE
(USAF STOCK NO. 6625-709-0288)

MODEL 803B

SERIAL NO. 3605 AND ABOVE
(USAF STOCK NO. 6625-972-4046)

JOHN FLUKE MANUFACTURING CO., INC.

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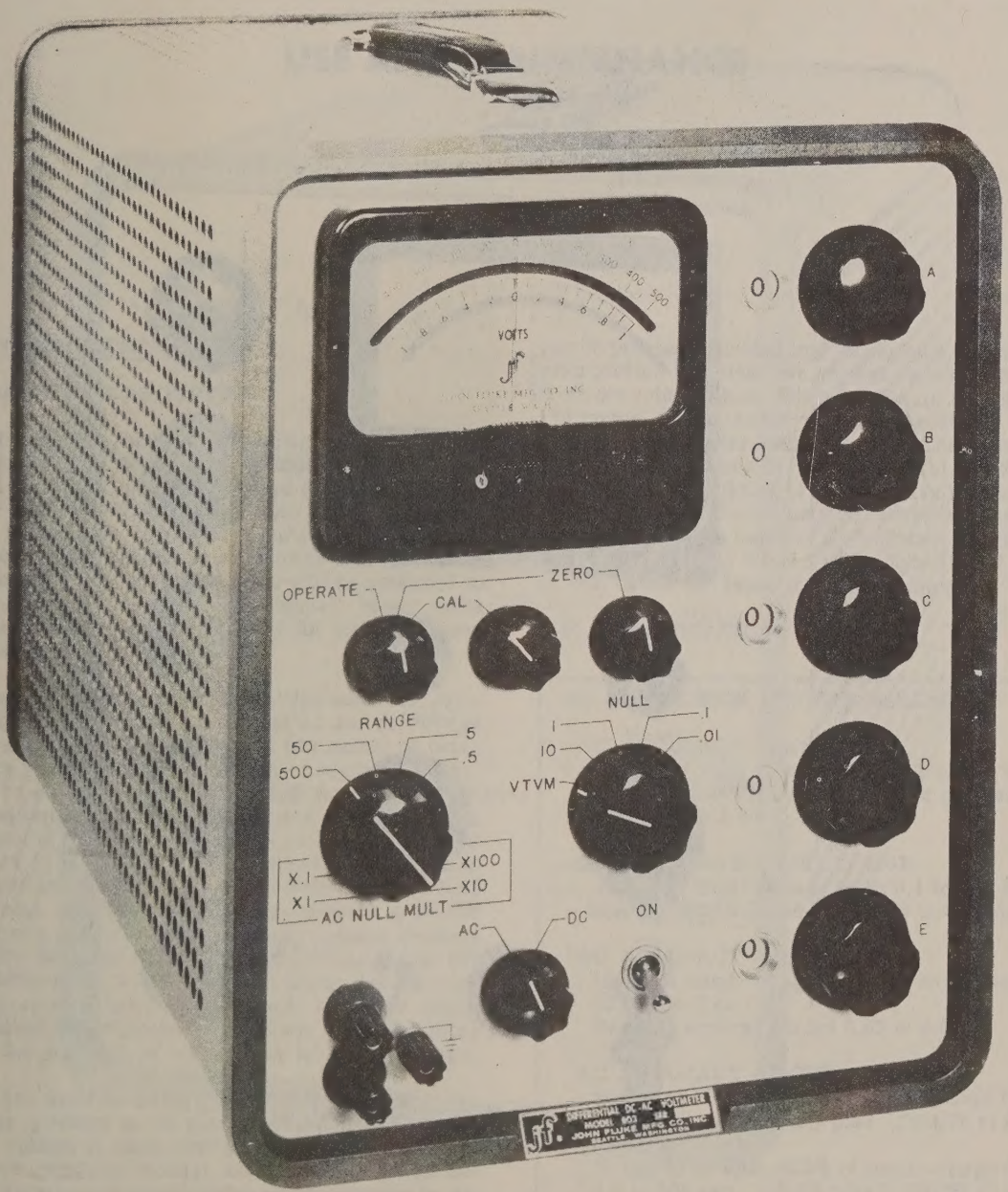


Figure 1-1. Model 803 AC/DC Differential Voltmeter

Figure 1-2. Model 803B AC/DC Differential Voltmeter

SECTION I

USE AND MAINTENANCE

1-1. INTRODUCTION

1-2. GENERAL DESCRIPTION

1-3. This manual contains instructions applicable to the John Fluke Model 803 AC/DC Differential Voltmeter, figure 1-1, serial number 9000 and on, Federal Stock Number 6625-709-0288, and the John Fluke Model 803B AC/DC Differential Voltmeter, figure 1-2, serial numbers 3605 and on, Federal Stock Number 6625-972-4046. The Model 803 and the Model 803B will be referred to as the voltmeter throughout this manual. Instructions in this manual are applicable to both models unless otherwise noted.

1-4. The voltmeter is a compact, highly accurate, portable instrument capable of precise ac and dc voltage measurements. This instrument is capable of being used as a vacuum tube voltmeter, as a precision potentiometer, and as a megohmeter for measurement of high resistance. It can also be used to measure the excursions of a voltage about some nominal value. The voltmeter is basically used for measurements of dc voltages from 0 to 500 volts and ac voltages from 0.05 to 500 volts. High accuracy measurements to 30,000 volts dc are possible with precision voltage dividers especially designed for use with the Fluke Model 800 series Differential Voltmeters. As additional features, the voltmeter contains an adjustable recorder output which makes the voltmeter particularly useful for monitoring the stability of almost any ac or dc voltage.

1-5. When used as a DC Differential Voltmeter, the voltmeter operates on the potentiometric principle. An unknown voltage is measured by comparing it to a known adjustable reference voltage with the aid of a null detector. An accurate standard for measurements is obtained by setting the reference supply with a standard cell. The known adjustable reference voltage is provided by a 500 volt dc power supply and five Kelvin-Varley decade resistor strings that are set accurately by five voltage readout dials. In this way, the 500 volts can be precisely divided into increments as small as 10 microvolts. The unknown voltage is then simply read from the voltage dials. When used as an AC Differential Voltmeter, the voltmeter operates essentially the same as for dc differential measurements. The ac input voltage is converted to a dc voltage and this dc voltage is measured by comparing it to a known adjustable reference voltage. In the highest null sensitivity range, potential differences between the unknown and the reference voltage of only 0.01 volts for dc and 0.001 volts for ac will cause full scale meter deflection.

1-6. SPECIFICATIONS

AS A PRECISION POTENTIOMETER

DC ACCURACY - MODEL 803
±0.05% of input voltage from 0.1 to 500 vdc
±0.1% or 0.00005 v, whichever is greater, from 0 to 0.1 vdc

DC ACCURACY - MODEL 803B
±0.05% of input voltage from 0.1 to 500 vdc
±(0.05% plus 0.00005 v) from 0 to 0.1 vdc

AC ACCURACY - MODEL 803
±0.2% of input voltage from 0.5 to 500 vac, 30 cps to 5 kc
Reduced accuracy from 0.05 to 0.5 vac

AC ACCURACY - MODEL 803B
20 cps to 10 kc: ±0.2% of input voltage from 0.5 to 500 vac. ±(0.2% plus 0.000025 v) from 0.001 to 0.5 vac
10 cps to 20 cps: ±0.5% of input voltage from 0.5 to 500 vac. ±(0.5% plus 0.000025 v) from 0.001 to 0.5 vac
5 cps to 10 cps: ±3% of input voltage from 0.5 to 500 vac. ±(3% plus 0.000025 v) from 0.001 to 0.5 vac

RANGE:

For DC Measurements

Input Voltage Range	Recommended Null Range*	Input Resistance per volt of input voltage	
		At Null	1% of Full Scale Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	Infinite	1,000 Meg
5-50	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
0.5-5	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	10,000 Meg
0-0.5	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	10,000 Meg

*Any null range may be used with any input voltage range; recommended ranges are those most useful.

For AC Measurements

Input Voltage Range	Recommended Null Range	Input Impedance
50-500	100-0-100	1 Meg, ▲
	10-0-10	1 Meg, ▲
	1-0-1	1 Meg, ▲
5-50	10-0-10	1 Meg, ▲
	1-0-1	1 Meg, ▲
	0.1-0-0.1	1 Meg, ▲
0.5-5	1-0-1	1 Meg, ▲▲
	0.1-0-0.1	1 Meg, ▲▲
	0.01-0-0.01	1 Meg, ▲▲
0.001-0.5	0.1-0-0.1	1 Meg, ▲▲
	0.01-0-0.01	1 Meg, ▲▲
	0.001-0-0.001	1 Meg, ▲▲

▲ 70 uuf for Model 803; 35 uuf for Model 803B

▲▲90 uuf for Model 803; 50 uuf for Model 803B

RESOLUTION:

Voltage Readout Dial Resolution

Range Setting	Null Setting	Resolution
500	any	10 mv
50	any	1 mv
5	any	0.1 mv
0.5	any	0.01 mv

Meter Resolution
(1/4 of a small scale meter division)

Polarity Setting	Range Setting	Null Setting	Resolution
DC	any	10	50 mv
DC	any	1	5 mv
DC	any	0.1	0.5 mv
DC	any	0.01	0.05 mv
AC	500	1	500 mv
AC	500	0.1	50 mv
AC	50	1	50 mv
AC	500	0.01	5 mv
AC	50	0.1	5 mv
AC	5	1	5 mv
AC	50	0.01	0.5 mv
AC	5	0.1	0.5 mv
AC	0.5	1	0.5 mv
AC	5	0.01	0.05 mv
AC	0.5	0.1	0.05 mv
AC	0.5	0.01	0.005 mv

AS A VACUUM TUBE VOLTMETER

ACCURACY: 3% on all ranges

RANGE:

	Voltage Ranges	Input Impedance
DC:	500-0-500	50 Meg
	50-0-50	50 Meg
	5-0-5	50 Meg
	0.5-0-0.5	50 Meg
	10-0-10*	10 Meg
	1-0-1*	10 Meg
	0.1-0-0.1*	10 Meg
	0.01-0-0.01*	1 Meg
AC:	0-500	1 Meg, ▲
	0-50	1 Meg, ▲
	0-5	1 Meg, ▲▲
	0-0.5	1 Meg, ▲▲
	0-100**	1 Meg, ▲
	0-10**	1 Meg, ▲
	0-1**	1 Meg, ▲
	0-0.1**	1 Meg, ▲
	0-0.01**	1 Meg, ▲▲
	0-0.001**	1 Meg, ▲▲

*These ranges are obtained by using Null ranges with all five voltage readout dials set to 0.

**These ranges are obtained by the proper setting of the range and null switches with all five voltage readout dials set to 0.

▲70 uuf for Model 803; 35 uuf for Model 803B

▲▲90 uuf for Model 803; 50 uuf for Model 803B

GENERAL SPECIFICATIONS, MODEL 803

STABILITY OF REFERENCE SUPPLY:
±0.0025% for a 10% change in line voltage
±0.01% per hour after 30 minute warmup

AC TO DC CONVERTER RESPONSE:
30 cps to 5 kc

INPUT POWER
115/230 volts AC (±10%) 50-60 cps,
75 watts

DIMENSIONS:
Cabinet Model - 13" high, 9-1/2" wide,
16" deep

WEIGHT:
Cabinet Model - 27-1/2 lbs.

GENERAL SPECIFICATIONS, MODEL 803B

REGULATION AND STABILITY OF 500 VOLT SUPPLY:

±0.0025% for a ±10% line change
±0.005% per hour after 30 minute warmup

STABILITY OF METER ZERO:

±0.5% of full scale for a 10% change in line voltage from a line frequency of 50 to 120 cps and ±1% of full scale for a 10% change in line voltage from a line frequency of 120 to 440 cps.

OPERATING TEMPERATURE RANGE

Within DC specifications from 40° to 105° F: Derate accuracy at 0.001% per °F outside these limits to 35° F and 110° F.

Within AC specifications from 55° F to 95° F: Derate accuracy at 0.005% per °F outside these limits to 35° F and 110° F.

RELATIVE HUMIDITY:

Within specifications from 0 to 80% relative humidity

SHOCK AND VIBRATION:

Meets requirements of MIL-T-945A

INPUT POWER:

115/230 volts AC (±10%), 50-440 cps, 75 watts.

DIMENSIONS:

Cabinet Model - 13" high, 9-1/2" wide, 16" deep.

WEIGHT:

Cabinet Model - 27-1/2 lbs.

1-7. INSTALLATION

1-8. The voltmeter is assembled, calibrated and checked out before being accepted. It is only necessary to unpack the instrument and it is ready for use. The instrument is wired for 115 volt operation. If 230 volt operation is desired, change jumper wires on power transformer terminal board as follows:

a. Remove two screws that secure case to chassis and slip instrument out of case.

b. Remove hardware which secures reference supply board to chassis. Carefully swing top of board downward to allow access to power transformer terminal board.

c. Remove jumpers from terminals N to O and P to R.

d. Solder a jumper across terminals O and P.

e. Secure reference supply board to chassis with hardware and replace instrument case.

f. Remove 1-1/2 ampere line fuse located at back of instrument and replace with 3/4 ampere fuse.

1-9. OPERATING INSTRUCTIONS

1-10. CONTROLS, TERMINALS, AND INDICATORS

1-11. The circuit symbol and a functional description of all external controls, terminals, and indicators on the voltmeter may be found in figure 1-3.

CONTROLS TERMINALS AND INDICATORS	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
Input terminals	J1, J3	Provided for connecting ac or dc voltage to be measured. These terminals are isolated from chassis ground.
Chassis ground terminal	J2	Provided for grounding purposes. A 0.47 uf capacitor is connected from the lower input binding post to the chassis ground post. Since the instrument is equipped with a three-wire line cord with the third wire fastened to the chassis, the external circuit should be checked for conflicts in grounding before connecting either input binding post to the chassis post.
Power toggle switch	S1	Applies ac line voltage to the primary circuit of the power transformer.
OPERATE-ZERO-CAL switch, Model 803	S4	Remains in the OPERATE position at all times except when it is necessary to zero the meter or calibrate the internal 500 volt dc reference supply. When set to ZERO, the meter indicates the difference between the output of the null detector with no voltage applied and a compensating voltage. When held in the CAL position, a representative sample of the reference voltage is compared to the voltage of an internal standard cell and any difference is indicated on the meter.
OPERATE-CALIBRATE switch, Model 803B	S4	Remains in the OPERATE position at all times except when it is necessary to calibrate the internal 500 volt dc reference supply. When held in the CALIBRATE position, a representative sample of the reference voltage is compared to the voltage of an internal standard cell and any difference is indicated on the meter.
ZERO control, Model 803	R227	Varies the compensating voltage to the chopper amplifier. When the OPERATE-ZERO-CAL switch is set to ZERO, the output of the chopper-amplifier is set to zero by adjusting the ZERO control for zero meter deflection.
CALIBRATE control, Model 803	R2	Varies the output of the 500 volt dc reference supply. When the OPERATE-ZERO-CAL switch is held in the CAL position, the reference supply is set accurately by adjusting the CAL control for zero meter deflection.
CALIBRATE control, Model 803B	R2	Varies the output of the 500 volt dc reference supply. When the OPERATE-CALIBRATE switch is held in the CALIBRATE position, the reference supply is set accurately by adjusting the CALIBRATE control for zero meter deflection.
RANGE switch	S2	Selects maximum input voltage ranges of 500, 50, 5, and 0.5 volts and ac null multipliers of X100, X10, X1, and X.1 to be used respectively with each voltage range.

Figure 1-3. Controls, Terminals, and Indicators (Sheet 1 of 2)

CONTROLS TERMINALS AND INDICATORS	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
NULL switch	S3	Set to VTVM for determining the approximate value of unknown voltage prior to differential measurements. Four null switch ranges of 10, 1, 0.1, and 0.01 volts are used for differential measurements. For the DC mode, the null ranges represent full scale differences between the unknown voltage and the amount of precision internal reference voltage that is set on the voltage readout dials. For the AC mode, the null range used times the applicable AC Null Multiplier, indicated by the range switch, represents the full scale difference between the unknown voltage and the amount set on the voltage dials.
A, B, C, D, and E voltage readout dials	S6, S7, S8, S9, S10	Select the amount of internal reference voltage necessary to null the unknown voltage. These dials also provide an in-line readout of the reference voltage.
Decimal lights	DS1, DS2, DS3, DS4	Serve as decimal points for the voltage readout dials. A different light illuminates for each position of the RANGE switch.
AC - DC switch, Model 803	S5	Selects the AC or DC mode of operation.
AC- - polarity switch. Model 303B	S5	Selects the AC, +DC, or -DC mode of operation. With this switch in the positive position, the polarity of the upper input binding post is positive with respect to the lower input binding post (middle post).
Output terminals	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
Output level control	R1	Varies the output level of the output binding post from 0 to approximately 20 millivolts full scale deflection.
Meter	M1	Indicates approximate voltage when used in VTVM mode and difference between unknown and internal reference voltage when used in differential mode. The upper scale, 500-0-500, is used when the NULL switch is set to VTVM. At all other times, the lower scale, 1-0-1, is used.
Mechanical zero control	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the internal meter terminals have been shorted.
Fuse	F1	Fuse holder protrudes from instrument to provide easy access to the fuse. The fuse is a 1.5 ampere slow blowing type for 115 volt operation and a 0.75 ampere slow blowing type for 230 volt operation.

Figure 1-3. Controls, Terminals, and Indicators (Sheet 2 of 2)

1-12. PRELIMINARY OPERATION, MODEL 803

WARNING

The round pin on polarized three-prong plug connects instrument case to power system ground. Use three-to-two pin adapter supplied with instrument when connecting to a two-contact receptacle. For personnel safety, connect short lead to a suitable ground.

a. Connect power plug to a 115 volt ac power source. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

b. Set controls as follows:

AC-DC	DC
RANGE	500
NULL	VTVM
all voltage readout dials	0 (zero)
power	ON

c. After a warmup period of at least 10 minutes, set OPERATE-ZERO-CAL switch to ZERO and adjust ZERO control for zero meter deflection.

d. Advance OPERATE-ZERO-CAL switch against spring tension to CAL, and adjust internal 500 volt dc reference supply with CAL control for zero meter deflection.

e. Set OPERATE-ZERO-CAL switch to OPERATE.

1-13. PRELIMINARY OPERATION, MODEL 803B

WARNING

The round pin on polarized three-prong plug connects instrument case to power system ground. Use three-to-two pin adapter supplied with instrument when connecting to a two-contact receptacle. For personnel safety, connect short lead to a suitable ground.

a. Connect power plug to a 115 volt ac power source. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

b. Set controls as follows:

RANGE	500 volts
NULL	VTVM
AC-dc polarity	+ (positive)
all voltage readout dials	0 (zero)
power	ON

c. After a warmup period of at least ten minutes, advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE, and adjust internal 500 volt dc reference supply with CALIBRATE control for zero meter deflection. Release OPERATE-CALIBRATE switch.

1-14. OPERATION AS A DC DIFFERENTIAL VOLTMETER

a. Perform preliminary operation procedure as stated in paragraph 1-12 (Model 803) or paragraph 1-13 (Model 803B).

b. Connect unknown dc voltage to input binding posts. When using the Model 803B, always connect the grounded side of the input to the lower input post (middle post).

c. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage on upper meter scale.

d. If meter needle deflection is to the left, the voltage being measured is negative. When using the Model 803, reverse the input connections. When using the Model 803B, set the AC-dc polarity switch to the negative position. In all cases the meter needle will deflect to the right.

e. Noting the position of illuminated decimal light, set five voltage readout dials to approximate voltage determined in step c. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage readout dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to O.

f. Set NULL switch to successively more sensitive null ranges, as indicated in figure 1-4 and adjust voltage readout dials for zero meter deflection in each null position. When the meter needle indicates to the right, the voltage under measurement is greater than the voltage set on the voltage readout dials. When the indication is to the left, the voltage is less than that set on the readout dials.

g. Read unknown voltage directly from the five voltage readout dials.

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SETTING
50-500	10 then 1 (then 0.1 for voltages from 50 to 100 volts)
5-50	1 then 0.1 (then 0.01 for voltages from 5 to 10 volts)
0.5-5	0.1 then 0.01
0-0.5	0.1 then 0.01

*Any null range may be used with any input voltage range; recommended settings are those most useful.

Figure 1-4. Recommended Null Settings

1-15. OPERATION AS AN AC DIFFERENTIAL VOLTMETER

a. Perform preliminary operation procedure as stated in paragraph 1-12 (Model 803) or paragraph 1-13 (Model 803B).

b. Set the AC-DC switch (Model 803) or AC-dc polarity switch (Model 803B) to AC.

c. Connect unknown ac voltage to input binding posts.

d. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on upper meter scale.

e. Noting the position of illuminated decimal light, set five voltage dials to approximate voltage determined in step d. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to 0.

f. Set null switch to 0.1 and then 0.01 volt, adjusting voltage dials for zero meter deflection in each position.

g. Read unknown voltage from the five voltage readout dials.

1-16. OPERATION AS A CONVENTIONAL VTVM

1-17. If it is desired to use the instrument as a VTVM only, additional ranges can be made available by converting the NULL ranges to VTVM ranges. This is made possible by setting the voltage readout dials to zero. Proceed as follows:

a. Perform preliminary operation procedure as stated in paragraph 1-12 (Model 803) or paragraph 1-12 (Model 803) or paragraph 1-13 (Model 803B).

b. Consult figure 1-5 and select full scale voltage deflection desired. If the approximate value of the voltage to be measured is unknown, select the 500 volt range initially.

c. Set controls as indicated for the range selected.

d. Connect voltage to be measured to input binding posts. Deflection to the right indicates that an unknown dc voltage is of positive polarity. An unknown ac voltage will always cause deflection to the right.

e. Read voltage from upper or lower scale as listed in figure 1-5.

Full-Scale Deflection	AC-DC Switch	Range Switch	Null Switch	Voltage Readout Dials	Meter Scale
DC:					
500-0-500	DC	500	VTVM	No effect	Upper
50-0-50	DC	50	VTVM	No effect	Upper
5-0-5	DC	5	VTVM	No effect	Upper
0.5-0-0.5	DC	0.5	VTVM	No effect	Upper
10-0-10	DC	No effect	10	All zero	Lower
1-0-1	DC	No effect	1	All zero	Lower
0.1-0-0.1	DC	No effect	0.1	All zero	Lower
0.01-0-0.01	DC	No effect	0.01	All zero	Lower
AC:					
0-500	AC	500	VTVM	No effect	Upper
0-50	AC	50	VTVM	No effect	Upper
0-5	AC	5	VTVM	No effect	Upper
0-0.5	AC	0.5	VTVM	No effect	Upper
0-100	AC	500	1	All zero	Lower
0-10	AC	500	0.1	All zero	Lower
		50	1		
0-1	AC	500	0.01	All zero	Lower
		50	0.1		
		5	1		
0-0.1	AC	50	0.01	All zero	Lower
		5	0.1		
		0.5	1		
0-0.01	AC	5	0.01	All zero	Lower
		0.5	0.1		
0-0.001	AC	0.5	0.01	All zero	Lower

Figure 1-5. VTVM Ranges

1-18. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. Perform preliminary operation procedure as stated in paragraph 1-12 (Model 803) or paragraph 1-13 (Model 803B).

b. Set the AC-DC switch (Model 803) or AC-dc polarity switch (Model 803B) to desired position.

c. Connect voltage to be observed to input binding posts. If meter needle deflection is to the left, the voltage being observed is negative. When using the Model 803B, set the AC-dc polarity switch to the alternate polarity position. When using the Model 803, reverse the input connections. In all cases the meter needle should deflect to the right.

d. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.

e. Set the five voltage readout dials to nominal voltage.

f. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.

g. Read voltage excursions from meter. Note that full scale right and left meter deflections are equal to the NULL voltage setting for dc measurements. For ac measurements, full scale right and left meter deflections are equal to the NULL voltage setting multiplied by the AC NULL MULT indicated by the RANGE setting. Figure 1-6 shows full scale ac deflections for the recommended settings of the range and null switches.

Range Switch Setting	Null Switch Setting	AC Null Multiplier	Full Scale AC Deflection (in volts)
500	1 0.1 0.01	X100	100 10 1
50	1 0.1 0.01	X10	10 1 0.1
5	1 0.1 0.01	X1	1 0.1 0.01
0.5	1 0.1 0.01	X0.1	0.1 0.01 0.001

Figure 1-6. Full Scale AC Deflection

1-19. USE WITH A RECORDER

1-20. Recorder output binding posts and an output level control are provided for monitoring the excursions of an unknown voltage from the voltage indicated by the voltage dial settings. If the leakage resistance between the recorder and ground is less than 10,000 megohms, the accuracy of the voltmeter will be impaired. Also, both input posts of the recorder should be able to stand 500 vdc to ground. The John Fluke Model A-70 Potentiometric Recorder (manufactured by the Texas Instrument Co.) is recommended for this application. Set up the recorder as follows:

a. Connect A-70 recorder to voltmeter with teflon leads as shown in figure 1-7.

CAUTION

Do not ground either of the voltmeter output terminals or either of the recorder input terminals. If any of these terminals are grounded, current will be drawn from the Kelvin-Varley voltage divider and the accuracy of the voltmeter will be completely destroyed.

b. After connecting the recorder, perform preliminary operation procedure as stated in paragraph 1-12 (Model 803) or paragraph 1-13 (Model 803B).

c. Check for excessive leakage as follows:

(1) Connect a dc voltage to the input of the voltmeter and differentially measure its potential in a recommended null range as instructed in paragraph 1-14.

(2) Alternately connect and disconnect the recorder leads from the output terminals of the voltmeter while noting the meter needle deflections. More than one-quarter of a small scale division deflection indicates that excessive leakage has been introduced by the recorder. This will impair the accuracy of the voltmeter.

(3) Disconnect the voltage.

d. After the leakage test has been successfully completed, short the input terminals of the voltmeter.

e. Set controls on the voltmeter as follows:

AC-dc polarity (Model 803B)	+ (positive)
AC-DC (Model 803)	DC
RANGE	50
NULL	10
voltage readout dials	10.000

The meter will indicate full scale deflection. This provides up to a maximum of approximately 20 millivolts at the output terminals depending on the setting of the output level control.

f. Adjust the output level control to obtain desired recorder deflection corresponding to full scale deflection of the voltmeter.

g. Remove the short from the input terminals of the voltmeter. The voltmeter and recorder are now ready for combined use. Proceed as instructed under paragraph 1-18.

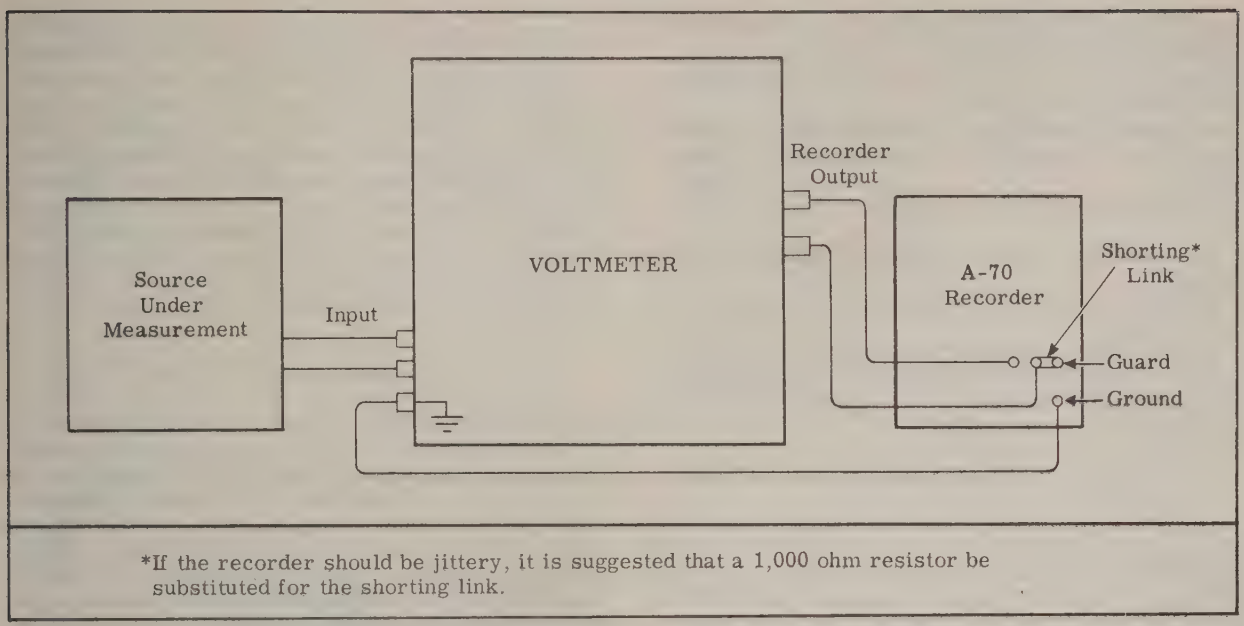


Figure 1-7. Recommended Recorder Connection Diagram

1-21. MEASUREMENT OF HIGH RESISTANCES

1-22. One of the important features of the voltmeter is its ability to be used as a megohmmeter for rapidly measuring high resistances from 1 megohm to 250,000 megohms. The following equation may be used to compute the resistance in megohms of an unknown connected to the input binding posts:

$$R_x = 10\left(\frac{E}{E_m} - 1\right) \text{ megohms,}$$

where:

R_x = unknown resistance to megohms

E = voltage indicated by voltage readout dials

E_m = voltage indicated on meter

10 = megohms of input resistance of VTVM circuit on 10, 1, and 0.1 null range.

When connecting the unknown resistance to the input terminals, use short isolated leads to prevent measuring leakage resistance between the leads.

1-23. FROM 1 MEGOHM TO 500 MEGOHMS. For rapid measurement of resistances from 1 megohm to 500 megohms, proceed as follows:

a. Perform preliminary procedure as stated in paragraph 1-12 (Model 803) or paragraph 1-13 (Model 803B).

b. Set RANGE switch to 500 and NULL switch to 10.

c. Connect unknown resistance between input terminals.

d. Adjust voltage readout dials for full scale meter deflection.

e. Subtract 10.00 from the amount set on the voltage readout dials to find the resistance of the unknown in megohms.

1-24. FROM 500 MEGOHMS TO 5,000 MEGOHMS. For rapid measurement of resistances from 500 megohms to 5,000 megohms, proceed as follows:

a. Perform preliminary procedure as stated in paragraph 1-12 or paragraph 1-13.

b. Set RANGE switch to 500 and NULL switch to 1.

c. Connect unknown resistance between input terminals.

d. Adjust voltage readout dials for full scale meter deflection.

e. Subtract 1.00 from the amount set on the voltage readout dials and multiply the result by 10 to find the resistance of the unknown in megohms.

1-25. FROM 5,000 MEGOHMS TO 50,000 MEGOHMS. For rapid measurement of resistances from 5,000 megohms to 50,000 megohms proceed as follows:

a. Perform preliminary procedure as stated in paragraph 1-12 or paragraph 1-13.

b. Set RANGE switch to 500 and NULL switch to 0.1.

c. Connect unknown resistance between input terminals.

d. Adjust voltage readout dials for full scale meter deflection.

e. Multiply the amount set on the voltage readout dials by 100 to find the resistance of the unknown in megohms.

1-26. FROM 50,000 MEGOHMS TO 250,000 MEGOHMS. To determine the value of an unknown resistance between 50,000 megohms and 250,000 megohms, proceed as follows:

a. Perform preliminary procedure as stated in paragraph 1-12 (Model 803) or paragraph 1-13 (Model 803B).

b. Set RANGE switch to 500 and NULL switch to 0.1.

c. Connect unknown resistance between input terminals.

d. Adjust voltage readout dials for a convenient meter deflection.

e. Divide the amount set on the voltage readout dials by the amount of voltage indicated on the meter and multiply the result by 10 to find the resistance of the unknown in megohms.

1-27. NOTES ON MEASURING AC OR DC VOLTAGES

1-28. ADJUSTMENT OF 500 VOLT SUPPLY AND ZEROING OF NULL DETECTOR, MODEL 803. The 500 volt dc reference supply adjustment and the null detector zero adjustment (paragraph 1-12, steps c. and d.) may be performed at any time deemed necessary without heed to the position of the switches and without removing any input or output connections. However, until the instrument has warmed up to an equilibrium temperature (about 1/2 hour), it should be adjusted prior to each specific measurement for best accuracy. When making prolonged measurements, allow one hour warmup time to ensure that the 500 volt reference supply does not shift during the final warmup phase.

1-29. ADJUSTMENT OF 500 VOLT REFERENCE SUPPLY, MODEL 803B. The 500 volt dc reference supply may be adjusted (paragraph 1-13, step c.) at any time deemed necessary without heed to the position of the switches and without removing any input or output connections. However, until the instrument has warmed up to an equilibrium temperature (about 1/2 hour), it should be adjusted prior to each specific measurement for best accuracy. When making prolonged measurements, allow one hour warmup time to ensure that the 500 volt reference supply does not shift during the final warmup phase.

1-30. GROUND LOOP PRECAUTIONS. Ground loop currents should be avoided to assure accuracy when making measurements. Potential differences are often found at different points on power system grounds. When this is the case, current may flow from the power system ground through the voltmeter and the equipment under measurement and back to the power system ground. To avoid this when the system being measured is grounded, do not connect input binding posts to chassis ground post.

1-31. USE OF SHORTING LINK. A 0.47 uf capacitor (C1) is connected from the lower input post to the chassis ground post to reduce the effect of circulating ac currents from the transformer. In some cases, it is possible for C1 to acquire a charge. For example, C1 will become charged when measuring positively grounded voltages because it is connected across the unknown voltage. Also, C1 will become charged through leakage resistance over a period of time if there is no external connection to the input terminals and the controls are set as follows: range to 500, null to any null range, ac - dc to dc, and voltage readout dials to several hundred volts. This condition may cause an error on low level measurements (under 5 volts) due to C1 discharging through the Kelvin-Varley divider. Connecting the shorting link from the lower input post to the chassis ground post will discharge C1 and thus prevent an inaccurate indication.

1-32. NOTES ON MEASURING DC VOLTAGES

1-33. RECOMMENDED NULL RANGES FOR DC MEASUREMENTS. Certain null ranges are recommended for use with each setting of the range switch for the following reasons: With the range switch at 500 volts, the last voltage readout dial (E) changes the reference voltage in steps of 0.01 volt. Therefore, the unknown voltage would have to be an exact multiple of 0.01 volt if a null is to be obtained on the 0.1 or 0.01 volt null range. Furthermore, it is unlikely that an unknown voltage of a few hundred volts will be stable within 10 millivolts. Although the regulation of the reference supply is more than adequate when the instrument is used in the recommended way, a badly fluctuating line voltage may cause the voltmeter to meter the regulation of its own 500 volt reference supply. For example, when measuring 500 volts with the Model 803, a line change of 10% may cause the 500 volt reference supply to change as much as 12.5 mv. Although this is small, the Model 803 will indicate full scale for a change as little as 100 mv or 10 mv if attempting to use the 0.1 or 0.01 null ranges.

1-34. EFFECT OF AC COMPONENTS ON DC MEASUREMENTS. An ac component of several times the unknown dc may be present on the unknown and the 803 will always indicate well within the specifications for frequencies over a few hundred cycles. An ac component may have an adverse effect if it is of a low frequency or if it has a frequency that is a multiple or sub-multiple of the chopper frequency. A double section low pass filter (R201, C201, R202, and C202) is used at the input of the null detector to reduce any ac present on the dc being measured. At lower frequencies, this low pass filter is less effective and the magnitude of the ac component is more significant. When the frequency is very close to a multiple or sub-multiple of the chopper frequency (approximately 60 cycles), the meter needle will oscillate at the difference frequency. For example, a 60 cycle ac voltage that is 5% of the input voltage will cause an error of approximately 0.01% which is well within the specifications. At low frequencies other than 60 cycles, a larger ac component can be tolerated. Also, since the input attenuation is less for the more sensitive null settings, the accuracy may be affected only on the more sensitive null settings. If ac components that affect the accuracy are ever encountered, additional filtering will be required. For an ac of a single frequency, a twin-T filter is effective and has the advantage of low total series resistance. For an ac var-

iable frequency, an ordinary low pass filter may be used. In either case, high quality capacitors of high leakage resistance should be used.

1-35. MEASUREMENT OF NEGATIVE DC VOLTAGES, MODEL 803. The Model 803 may be used to measure voltages which are negative with respect to ground as well as the more commonly encountered floating and positive variety. However, when the upper input post is connected to chassis or line ground, either at the voltmeter or at the source under measurement, a 0.47 uf capacitor (C1) is placed directly across the input. In certain circuits this capacitance may affect the source voltage. Also, C1 will charge and discharge to the difference between the unknown voltage and internally known voltage through the input resistance when in a null range. This will have little effect if the voltage readout dials are set to the approximate value of unknown voltage before switching to a null range.

1-36. MEASUREMENT OF NEGATIVE DC VOLTAGES, MODEL 803B. Because of a polarity switch, voltages which are negative with respect to ground as well as the more commonly encountered positive voltages may be measured with equal facility. If the upper input post is connected to the metal case or line ground, either at the voltmeter or at the source under measurement, the accuracy of the voltmeter may be reduced. If the unknown voltage is grounded, always connect the grounded side to the lower input post (middle post) and use the polarity switch to obtain the proper result.

1-37. NOTES ON MEASURING AC VOLTAGES

1-38. ERRORS DUE TO DISTORTION. The ac to dc converter in the voltmeter is an average measuring device calibrated in rms. The converter will put out a dc voltage that is proportional to 1.11 times the average value of the ac input voltage. Thus, if the input signal is not a true sinusoid, the voltmeter reading is probably in error because the ratio of rms to average is usually not the same in a complex wave as in a sine wave. The magnitude of the error is dependent on magnitude of the distortion and on its phase and harmonic relationship with respect to the fundamental. Figure 1-8 indicates how the accuracy will be affected by various harmonics for different percentages of distortion. If the distortion present in the signal is composed of even harmonics and is less than 2%, the error between the voltmeter reading and true rms is fairly minor. A larger error can occur if the distortion is composed of odd harmonics, especially the third harmonic. Note that for 2% of third harmonic distortion the error in the reading could range from 0 to 0.687%.

1-39. ERRORS DUE TO GROUNDING. In the voltmeter there is a 0.47 uf capacitor connected from the lower input terminal (middle post) to chassis ground. If it is desired to make measurements where the voltage to be connected to the lower input terminal is not at ground potential, a line cord adapter must be used to isolate the voltmeter chassis from line ground. Otherwise, the 0.47 uf capacitor would place an ac load on the circuit being measured.

Harmonic	% Distortion	% Error From True RMS*	
		Maximum Positive	Maximum Negative
Any even harmonic	0.1	0.000	0.000
	0.5	0.000	0.0001
	1.0	0.000	0.005
	2.0	0.000	0.020
Third harmonic	0.1	0.033	0.033
	0.5	0.167	0.168
	1.0	0.328	0.338
	2.0	0.667	0.687
Fifth harmonic	0.1	0.020	0.020
	0.5	0.099	0.101
	1.0	0.195	0.205
	2.0	0.380	0.420

*Error depends upon phase relationship between harmonic and fundamental, i.e. error can be any value between maximum positive and maximum negative, including zero.

Figure 1-8. Percent Error Due to Harmonic Distortion

1-40. INTERNAL CONVERTER NOISE. When the instrument is shorted in the ac mode, the converter may produce a residual noise output of approximately 100 uv. This noise voltage will cause an insignificant error as long as ac input signals of 1 mv or larger are applied to the instrument. Figure 1-9 shows a typical half wave of the signal voltage at the output of the converter amplifier. It is easily seen that the noise contributes very little to the average value of the signal and is well within the accuracy of the instrument.

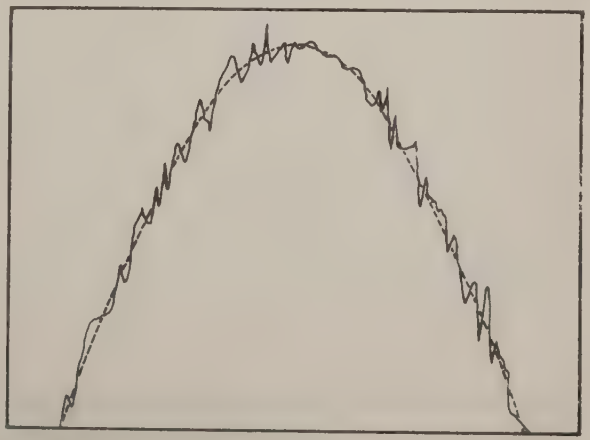


Figure 1-9. Signal Voltage with Converter Noise

1-41. THEORY OF OPERATION

1-42. GENERAL

1-43. As shown in the block diagram of figure 1-10, the AC/DC Differential Voltmeter consists basically of an ac to dc converter, a dc vacuum tube voltmeter (vtvm), and a 0 to 500 volt dc reference supply. Refer to the schematic diagram, figure 1-20 (Model 803), figure 1-21 (Model 803B), for more detail. The overall operation of the voltmeter may be summarized as follows. To measure the approximate value of a dc voltage, the unknown voltage is connected directly to the dc vtvm. To accurately measure a dc voltage, the unknown voltage is connected across the series combination of the dc vtvm and the 0 to 500 volt dc reference supply. The reference supply voltage is then adjusted with the five voltage readout dials until it matches the unknown voltage as indicated by the vtvm. All ac measurements are made by first converting the ac input voltage to a dc voltage by means of the ac to dc converter. The voltmeter then operates essentially the same as for approximate and accurate dc measurements.

1-44. DC VACUUM TUBE VOLTMETER

1-45. GENERAL. The dc vtvm is composed of an attenuator, a chopper amplifier, and a meter. The heart of the dc vtvm is the chopper amplifier in which the dc signal input is modulated by an electromechanical chopper, amplified by a conventional three stage resistance-capacitance coupled amplifier, rectified by the chopper, and finally filtered to produce a dc output. The chopper amplifier has a high amount of negative current feedback. This makes the output current approximately equal to the signal voltage divided by the impedance of the feedback network, regardless of the amplifier characteristics. The output current from the chopper-amplifier is indicated on the meter. The attenuator is used to reduce the voltage span of each range to a common range usable by the chopper-amplifier to produce a proper meter deflection.

1-46. OPERATION. At the input to the null detector, R201, C201, R202, and C202 form a double section low pass filter that reduces any ac component present on the dc voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network is converted to an alternating voltage by G1, a 60 cycle chopper. This chopped voltage is amplified by V202, V203A, and V203B. During half the chopper cycle the output of the amplifier is clamped to approximate null detector common potential by G1 while during the other half the output is filtered by C212 to provide a dc current for the meter. When the chopper provides connection between contacts 1 and 7 a voltage is developed across feedback network R218 and R219 that is proportional to the meter (output) current. This feed-

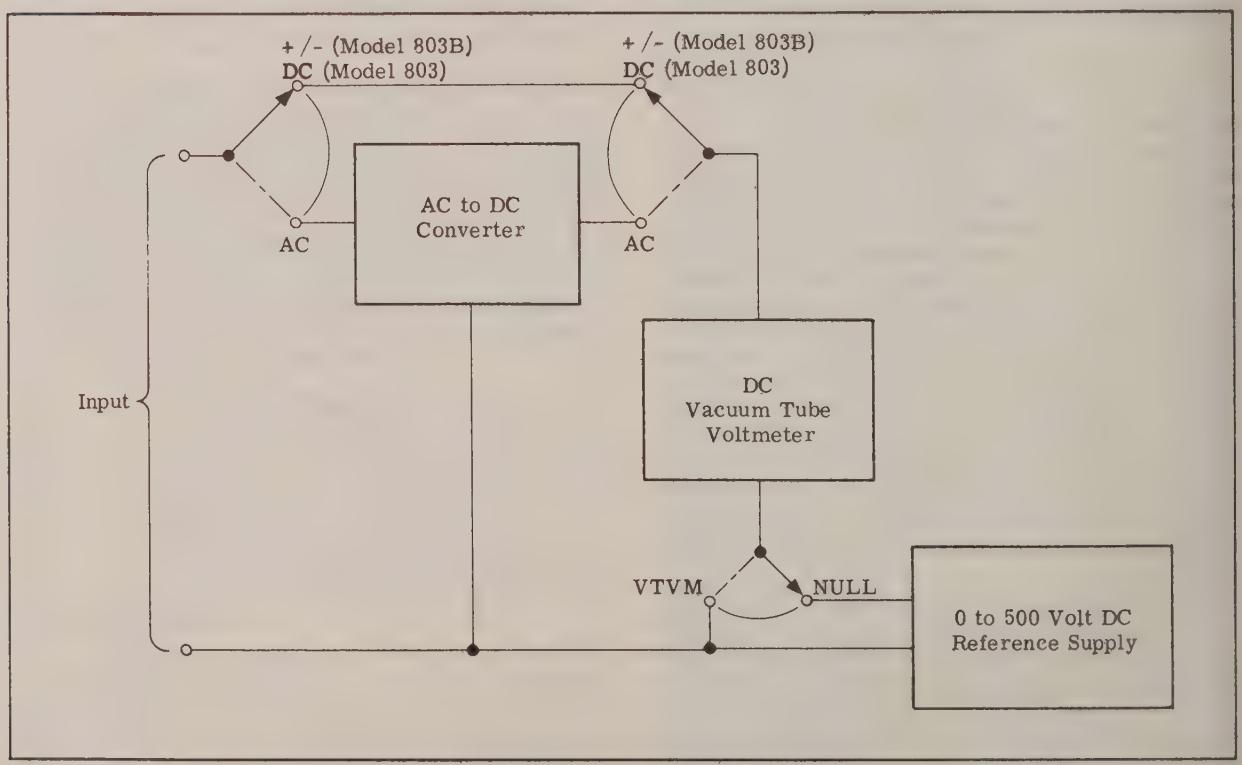


Figure 1-10. AC/DC Differential Voltmeter Block Diagram

back voltage effectively reduces the magnitude of the voltage that is chopped and applied to the input of the amplifier. The impedance of the feedback network (R218 and R219) is adjustable. The output current is around 100 ua and can be set accurately by means of the feedback network. Current feedback makes the output current essentially proportional to the signal voltage. For full scale deflection, a 10 mv signal voltage will cause 100 ua to flow through the meter.

1-47. In the dc vtvm mode, four positions on the vtvm attenuator selected by range switch section S2C provide the necessary reduction of the 500 50, 5, and 0.5 volt ranges for proper chopper-amplifier input. For this mode, the resistance of the attenuator and thus the input resistance of the voltmeter is 50 megohms (R301 through R310). In the dc differential mode, the voltage difference (unknown voltage minus reference voltage) is reduced by three positions on the vtvm attenuator selected by null switch section S3A to give full scale deflections corresponding to inputs of 10, 1, and 0.1 volts. For full scale deflection corresponding to 0.01 volt, the voltage across the attenuator is fed directly to the chopper amplifier. Although the resistance of the vtvm attenuator is 10 megohms (R305 through R310) for the 10, 1, and 0.1 volt null ranges and 1 megohm (R306 through R310) for the 0.01 volt null range; this is not the input resistance of the voltmeter. The input resistance is determined by dividing the unknown terminal voltage by the current drawn from the unknown. Since the reference voltage is equal to the unknown voltage at null, no current is drawn from the unknown and the input resistance is therefore infinite.

1-48. In the ac vtvm mode, null switch section S3A and ac - dc switch section S5E (Model 803), S5L (Model 803B) provide connection to only one position on the vtvm attenuator regardless of where the range switch is set. This is because the output of the ac to dc converter is 5 volts dc for full input on each range. In the ac differential mode, the voltage difference (converter output voltage minus reference voltage) is reduced by the same positions on the vtvm attenuator as for dc differential measurements. Because of this and the fact that the converter puts out 5 volts dc for full input on each range, the null range used must be multiplied by the ac null multiplier indicated by the range switch to find the full scale difference between the unknown voltage and the reference voltage. The input impedance for the ac vtvm and ac differential mode depends on the input impedance of the ac to dc converter and its attenuator. The input impedance is thus dependent on the setting of the range switch and for the Model 803 is 1 megohm, 70 uuf for the 500 and 50 volt ac ranges, and 1 megohm, 90 uuf for the 5 and 0.5 volt ac ranges. The input impedance for the Model 803B is 1 megohm, 35 uuf for the 500 and 50 volt ac ranges, and 1 megohm, 50 uuf for the 5 and 0.5 volt ac ranges.

1-49. GAIN AND ZERO ADJUSTMENTS. Variable resistor R227 in the power supply provides a means of adjusting the output current of the amplifier to zero when there is no input signal. The gain of the amplifier is adjusted by means of R219 in the feedback circuit.

1-50. RECORDER OUTPUT. The recorder output is picked off divider string R222, R1, and R223. Output level control R1 provides a means of adjusting the output voltage up to a maximum of approximately 20 millivolts at full scale deflection. The voltage at the output terminals is proportional to the meter reading.

1-51. 0 TO 500 VOLT REFERENCE SUPPLY

1-52. GENERAL. When the voltmeter is used for differential voltage measurements, an internal voltage is nulled or matched against the unknown voltage. An extremely accurate reference voltage is therefore required. This is obtained from the 0 to 500 volt reference supply. The 0 to 500 volt reference supply is composed of a well regulated 500 volt reference supply, a range divider, and a Kelvin-Varley five decade attenuator. The output of the 500 volt power supply is applied directly to the Kelvin-Varley attenuator for the 500 volt dc range. In the 50, , and 0.5 volt dc ranges, the range divider reduces the voltage to 50, 5, and 0.5 volts before it is applied to the Kelvin-Varley attenuator. For any ac range, the range divider always reduces the voltage to 5 volts. The Kelvin-Varley attenuator divides its input voltage (500, 50, 5, or 0.5 volts) into 50,000 equal increments any number of which may be selected by setting the five decades with the voltage readout dials. The output of the Kelvin-Varley attenuator, therefore, provides an extremely accurate reference voltage.

1-53. OPERATION. The 500 volt reference supply uses three diodes (CR101, CR102, and CR103) and a filter network (R109, R110, C101, and C102) to supply unregulated dc voltage to series passing tube V101. The voltage is regulated by comparing a sample of the output voltage tapped off a divider string (R123, R124, R121, and R2) with the voltage from reference tube V102 in differential amplifier V104. The output of V104 is fed to differential amplifier V105 which drives the grid of series passing tube V101. The control action of the differential amplifiers continuously adjusts the voltage drop across the series passing tube so as to keep the sample voltage equal to the voltage of the reference tube. Any difference in voltage, the error, is amplified by V104 and V105 and thus changes the voltage drop across V101 to maintain the output at 500 volts. In the 500 volt dc range the output of the reference supply is passed directly to the Kelvin-Varley divider by range Section S2F. In the 50, 5, and 0.5 volt dc positions, range resistors (R320 through R330) selected by section S2E divide the reference voltage to 50, 5, and 0.5 volts before it is switched to the Kelvin-Varley attenuator by section S2E. During ac operation with the Model 803, ac-dc switch section S5C provides connection to the range resistors that divide the reference to 5 volts. This 5 volts is then passed to the Kelvin-Varley attenuator by section S5B. During ac operation with the Model 803B, ac-dc polarity switch section S5G provides connection to the range resistors that divide the reference to 5 volts. This 5 volts is then passed to the Kelvin-Varley attenuator by section S5H. The voltage applied to the Kelvin-Varley attenuator is always 5 volts for ac because the ac to dc converter always supplies up to a maximum of 5 volts to the vtvm attenuator.

1-54. The five Kelvin-Varley decade resistor strings R401 through R449 and associated voltage dials A through E (S6 through S10) provide a means of making the four precision voltages (500, 50, 5, and 0.5) adjustable. Note that each string, with the exception of the first, parallels two resistors of the preceding string. Between the two wipers of S6 (voltage dial A) then, there is a total resistance of 40K (80K paralleled by 80K). With the range switch in the 500 volt position, a total voltage of 100 volts dc will appear across these two wipers. Also, there will be 10, 1, and 0.1 volts dc across the wipers of S7, S8, and S9, respectively. Voltage dial E (S10) picks increments of 0.01 volt dc from the last decade. These voltages are reduced by a factor of 10 for each lower voltage range. All resistors of each decade are matched and the three most critical decades (40K, 8K, and 1.6K) are matched for each instrument, providing an overall accuracy of 0.01% absolute. With the null switch in any null range, the output of the Kelvin-Varley attenuator is connected in series with the vtvm attenuator thus providing the accurate 0 to 500 volts reference supply required.

1-55. ADJUSTMENTS. Variable resistor R121 is used during calibration to set the reference supply to 500 volts with calibrate control R2 set at its center of rotation. This allows the reference supply to be adjusted to 500 volts by means of the calibrate control at any time. With the operate-zero-cal switch (Model 803) or operate-calibrate switch (Model 803B) held at calibrate, a fixed percentage of the reference supply is compared to the precise potential of an internal standard cell. Any difference in potential is fed to the chopper amplifier to give an indication on the meter so that the reference supply can be set with the calibrate control. The fixed percentage of the reference supply is set accurately during calibration by means of R318. The 50, 5, and 0.5 volt range resistor networks are set accurately during calibration by means of R323, R326, and R329.

1-56. AC TO DC CONVERTER

1-57. GENERAL. The ac to dc converter is essentially an operational amplifier containing three resistance-capacitance coupled amplifier stages with high negative feedback. The amplifier achieves a midband loop gain of approximately 70 db with a virtually flat frequency response from 30 cps to 5 kc for the Model 803, 20 cps to 10 kc for the Model 803B. High negative feedback makes the amplifier practically noise free and relatively insensitive to gain changes in individual tubes due to aging and tube replacement. At the output of the amplifier, full-wave rectification is used to return negative feedback to the grid of the first amplifier tube. Half-wave rectification and filtering is utilized to produce a dc voltage that is proportional to the average value of the ac input voltage. The output is calibrated to indicate the rms value of a pure sine wave.

1-58. OPERATION. All ac measurements are made by first converting the ac input voltage to a dc voltage. The converter provides a dc output of 5 volts when full range voltage is applied to the voltmeter in each ac range. In the 5 volt ac position, range switch sections S2G and S2H connect the input binding posts directly to the converter input. In this case, the converter feedback is such that the dc output voltage is equal to the rms value of the converter input ac voltage. In the 0.5 volt ac position, range switch section S2I connects to feedback resistors that allow the converter to produce a dc output that is equal to ten times the ac input. Thus, an output of 5 volts dc is provided for a full range input of 0.5 volt ac. In the 500 and 50 volt ac positions on the Model 803, an input attenuator reduces the unknown ac by a factor of 100 to provide a maximum of 5 and 0.5 volts ac input to the converter. Range switch section S2I provides connection to the same feedback resistors for the 500 volt range as for the 5 volt range and the same for the 50 volt range as for the 0.5 volt range. In the 500 and 50 volt ac positions on the Model 803B, input attenuators reduce the unknown to a maximum of 5 volts ac input to the converter. Range switch section S2I provides connection to the same feedback resistors for the 500 and 50 volt range as for the 5 volt range. Thus an output of 5 volts dc is obtained from the converter for full input on any range.

1-59. NULL INDICATIONS. When making ac differential measurements, the null range used times the applicable ac null multiplier must be used to represent full scale on the meter. This is due to the way that the converter is constructed. For the 500 volt ac range, the converter produces a dc output voltage equal to 1/100 of the ac input voltage. Thus, the ac null multiplier for the 500 volt range position is X100. For example, when the range switch is set to 500 and the null switch is set to 0.01. full scale meter deflection represents a one volt (100 x 0.01) difference between the unknown voltage and the amount set on the voltage readout dials. By similar reasoning, the multipliers for the 50, 5, and 0.5 volt ac ranges are X10, X1, and X0.1, respectively.

1-60. ADJUSTMENTS, MODEL 803. Variable resistor R535 provides a means of adjusting the output voltage of the converter to zero when there is no signal input. For 0.5 volt converter gain, R536 at the output of the converter is adjusted. The gain of the amplifier for the 5 volt range is adjusted by means of R541 in the feedback network. The high frequency response of the amplifier input is adjusted by means of C504 while C519 adjusts the high frequency response of the 0.5 volt feedback circuit. The attenuation of the 50 and 500 volt attenuator is adjusted with R503 and the attenuator high frequency response is adjusted with C501.

1-61. ADJUSTMENTS, MODEL 803B. For 0.5 volt converter gain, R536 at the output of the converter is adjusted. The gain of the amplifier for the 500, 50, and 5 volt ranges is adjusted by means of R541 in the feedback network. The high frequency response of the amplifier input is adjusted by means of C504 while C519 adjusts the high frequency response of the 0.5 volt feedback circuit. The attenuation of the 500 volt attenuator is adjusted with R534 and the attenuator high frequency response is adjusted with C523. The attenuation of the 50 volt attenuator is adjusted with R503 and the attenuator high frequency response is adjusted with C501.

1-62. AC-DC POLARITY SWITCH, MODEL 803B.

1-63. The ac-dc polarity switch is provided for selecting either the ac or dc mode of operation. When set to ac, the ac to dc converter is switched into the circuit by sections S5I and S5K. Sections S5G and S5H are used to switch 5vdc to the Kelvin-Varley divider. When in the ac vtvm mode, S5L is used to provide the proper attenuation for the null detector input. The ac-dc polarity switch may be set to positive or negative for the dc mode of operation. As seen in figure 1-11, the ac-dc polarity switch reverses the input posts, the meter, and the internal reference supply. This causes the meter needle to deflect to the right whenever the input voltage is greater than the adjustable reference voltage. Section S5E connects 110 megohms (R311 through R315) in parallel with C1 during the negative dc mode of operation to prevent charge accumulation on C1 from giving false meter indications.

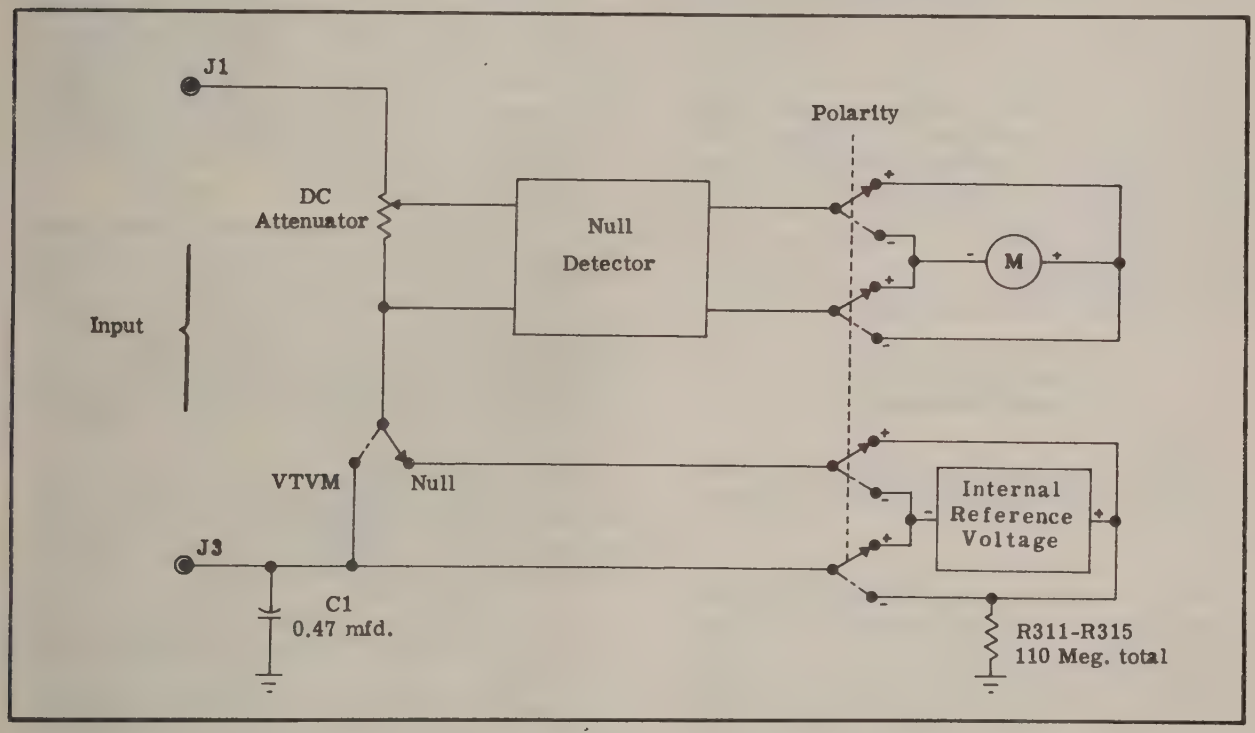


Figure 1-11. DC Function of AC-DC Polarity Switch, Model 803B

1-64. MAINTENANCE

WARNING

Use extreme care when working inside the instrument while it is on. Tube shields and capacitor cans on the null detector board will be at a voltage close to that indicated by the voltage readout dials.

NOTE

At the time of repair, calibration, or removal of the chassis from the case, a locally fabricated warning decal, stencil or equivalent marking should be placed on the chassis near the null detector board stating "Danger, High Voltage".

1-65. PREVENTIVE MAINTENANCE

1-66. The accuracy of the voltmeter is adversely affected by excessive electrical leakage from the input of the null detector to either ground or the 500 volt reference supply. Special care has been taken to prevent leakage across certain critical switch wafers and areas of some printed circuit boards due to moisture from condensation. The printed circuit boards have been coated with Humi-Seal 1B12. On the Model 803, the range, null, operate-zero-cal, and ac-dc switches have been dipped in Dow-Corning silicone oil. On the Model 803B, the range, null, operate-calibrate, and ac-dc polarity switches have been dipped in Dow Corning silicone oil. Accumulations of dust and foreign matter will cause internal leakage, and should be removed as often as necessary.

1-67. To check for excessive electrical leakage, proceed as follows:

a. Perform preliminary operation procedure as stated in paragraph 1-12 (Model 803) or paragraph 1-13 (Model 803B).

b. Set controls as follows:

AC-dc polarity (Model 803B)	+ (positive)
AC-DC (Model 803)	DC
RANGE	500
NULL	0.1
voltage read-out dials	490.00

c. Remove test leads from input posts.
d. Excessive leakage is indicated if the meter deflects more than one-tenth of full scale.

1-68. To prevent excessive electrical leakage, proceed as follows:
a. Blow the instrument out with low-pressure, clean, dry air to remove most accumulations of dust and foreign matter. Pay particular attention to the binding posts, binding post wiring, and critical switches (NULL, RANGE, OPERATE-ZERO-CAL, and AC-DC on the Model 803; NULL, RANGE, OPERATE-CALIBRATE, and AC-dc polarity on the Model 803B).
b. Clean the binding posts, insulators, and front panel with a rag saturated in anhydrous denatured ethyl alcohol.

CAUTION

Do not use Metriclene, acetone, lacquer thinner, or any other methyl ethyl ketones, since they will react with the Lexan rotor on the CTS plastic switches.

c. When necessary, wash all exposed dielectric surfaces of the critical switches with denatured alcohol using a small, stiff-bristled brush.
d. After washing, recoat the exposed switch insulating material with a solution of Dow Corning 200 having a viscosity between 50 and 20 centistokes. This prevents leakage due to moisture on these surfaces.

1-69. CORRECTIVE MAINTENANCE

1-70. TROUBLESHOOTING. The purpose of troubleshooting is to quickly and accurately determine the cause of any abnormal condition. To assist in localizing most troubles which might occur, the causes and remedies for a number of symptoms are listed in the troubleshooting chart (figure 1-12). Since failure of the voltmeter is usually due to tube failure, it is recommended that tube substitution be tried before any other tests are made. However, the voltmeter is conservatively designed and should require very infrequent tube replacement. At certain times, a check of the dc pin voltages in the tubes (figure 1-13) is also useful. As an aid, to troubleshooting, components may be located by referring to the figures in section II (Model 803) or section III (Model 803B). An understanding of the theory of operation (paragraph 1-41) and frequent reference to the schematic diagram (figure 1-20, Model 803; figure 1-21, Model 803B) will be of great value in troubleshooting.

WARNING

Use extreme care when working inside the instrument while it is on. All metal components on the null detector board will be at a voltage close to that indicated by the voltage readout dials.

1-71. TUBE REPLACEMENT. Replacement of tubes will not normally necessitate complete recalibration. If V202 or V203 is replaced, calibrate the null detector per paragraph 1-80 (Model 803) or paragraph 1-82 (Model 803B). After replacing V102, V103, V104 or V105 calibrate the reference supply per paragraph 1-81 (Model 803) or paragraph 1-83 (Model 803B). If V501 or V502 is replaced, calibrate the ac to dc converter per paragraphs 1-86 through 1-92 (Model 803) or paragraphs 1-93 through 1-101 (Model 803B).

1-72. COMPONENT REPLACEMENT. Should it ever become necessary to replace a component on a printed circuit board, proceed as follows:
a. Clean soldered area around component with methyl ethyl ketone.
b. Remove part and install a new component.
c. Remove flux with du Pont Freon PC.
d. Allow to dry for 10 minutes. When it is cool or humid, it may be necessary to place area under a lamp to ensure thorough drying.
e. Coat any uncoated areas around R305 through R310 on the Range Resistor Board and around the input to the Null Detector Board (tube V202, EF-86/6267, and chopper) with Humi-Seal 1B12 (manufactured by Columbia Technical Corp. of Woodside, N. Y.).

1-73. STANDARD CELL PROBLEMS. The standard cell deserves special consideration if it is suspected of being faulty:
a. The standard cell used is a miniature low hysteresis unit which has excellent long term stability and negligible temperature hysteresis. (Hysteresis is a temporary increase in EMF immediately following a decrease in temperature; this effect should not be confused with temperature coefficient.) Under normal conditions this cell should last from 8 to 15 years. In rare instances, failure has occurred in less than 2 years. End of life is usually marked by an increase in temperature hysteresis effect. That is, reading errors in excess of specification will result when the same voltage is read with the voltmeter hot and cold. Should replacement of the cell become necessary for any reason, the reference supply must be recalibrated per paragraph 1-81 (Model 803) or paragraph 1-83 (Model 803B). This is because the emf of different cells may be different by as much as 0.05% and each instrument is calibrated to its own cell.
b. Failure of the standard cell may occur if subjected to below freezing temperature. The electrolyte will freeze at 1° F and operation below 32° F is definitely not recommended. The life of the cell also will be greater if the voltmeter is not operated at elevated temperature. The 8 to 15 year figure holds for operation of the instrument in normal room temperature.

c. The EMF of the standard cell will change if the cell has been inverted, or if the cell has been inadvertently short-circuited. If the EMF has changed, the voltmeter will naturally be out of calibration on all ranges. In either case, the cell will return to its original EMF. If the cell is inverted or shorted for only a few seconds, the voltmeter should be able to measure voltages within specifications after several hours recovery time.

1-74. DECIMAL LAMP REPLACEMENT. The decimal lamps are normal 6.3 volt bulbs. To prolong their life, these bulbs are operated from a 5 volt transformer winding. However, these bulbs do occasionally fail. To replace, proceed as follows:

a. Remove screws at back of cabinet and slide instrument out of case.

b. Remove four screws that hold front panel assembly to chassis.

c. Being careful to avoid wiring damage, gently lift front panel assembly from instrument and set face down in front of instrument.

d. Remove screws holding range resistor board and Kelvin-Varley board to front panel assembly.

e. Push these boards aside enough to allow access to pilot light holders.

f. Remove pilot light holder from bracket by applying pressure to each side of holders.

g. Remove cardboard light shield and replace pilot light.

h. Replace light shield and insert light holder into bracket.

i. Replace range resistor board and Kelvin-Varley board and secure front panel to chassis.

j. Replace instrument in cabinet.

SYMPTOM	PROBABLE CAUSE	REMEDY
Drift of the 500 volt dc reference supply evidenced by the continual need for resetting with the CAL control (Model 803) or CALIBRATE control (Model 803B).	V102, V104, or V105 defective.	Check V102, V104 and V105 by replacement.
	One of the sampling string resistors (R123, R124, R121) is changing value rapidly as the instrument warms up.	Locate faulty resistor by heating slightly with a soldering iron held near the resistor while observing the 500 volt dc calibration.
	Drifting standard cell EMF possibly caused by previous shorting or inverting of the cell.	Allow time for the standard cell to stabilize. Several hours should be sufficient.
Cannot calibrate 500 volt dc reference supply. Meter cannot be brought to zero with CAL control (Model 803); CALIBRATE control (Model 803B).	Excessive aging of V102.	Check V102 by replacement.
	Out of calibration.	Recalibrate per paragraph 1-78.
	One or more resistors in 500 volt dc sampling string has shifted in value.	Recalibrate per paragraph 1-78 and observe stability for 48 hours. If 500 volt dc reference supply remains stable replacement of resistor is unnecessary.
	Standard cell EMF has shifted.	Recalibrate instrument and observe stability of reference supply. Replacement of the standard cell may be necessary.
Measurements are out of tolerance on any range when the Kelvin-Varley divider is dialed to any setting other than 499910.	One of the Kelvin-Varley divider resistors is out of tolerance.	Measure the voltage drop across each Kelvin-Varley resistor with another John Fluke Differential Voltmeter. Begin by setting RANGE switch to 500 volts and the voltage readout dials to 499.910. Reference to the schematic diagram will show that there should be 100, 10, 1, 0.1, and 0.01 volts respectively across each resistor of the A, B, C, D, and E decades, except for the two resistors of each decade that are paralleled by the following decade. Across these two resistors, there should be 50, 5, 0.5, and 0.05 volts, respectively. Measure all voltages ±0.05%. Remember that if one resistor in a decade has increased or decreased appreciably, the voltage drop across all other resistors in the decade will be slightly affected also.

Figure 1-12. Troubleshooting (Sheet 1 of 3)

SYMPTOM	PROBABLE CAUSE	REMEDY
Measurements are out of tolerance on all ranges other than 500 volt.	R320 or R321 has shifted in value.	It may be possible to correct all range voltages by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on one range other than 500 volt.	A reference supply output range resistor on the range resistor printed circuit board is out of tolerance.	If the trouble occurs in the 50 volt range, R324 has shifted; in the 5 volt range, R325 of R327 has shifted; in 0.5 volt range, R328 or R330 has shifted. It may be possible to correct by recalibration. If not, replace faulty resistor.
Instrument is out of specifications on all ranges.	Resistors R306, R307, R308, R309, or R310 out of tolerance.	Check and replace faulty resistor.
Meter rattle, drift, or error is observed on all null ranges.	V202 or V203 faulty. Chopper G1 faulty. Moisture or dirt on printed circuit boards or switches.	Check V202 and V203 by replacement. Replace chopper. Clean instrument.
NOTE: Assuming all dc measurements are normal, the following symptoms are common to ac measurements only.		
Measurements are out of tolerance on 50 and 500 volt ac range only, Model 803.	Out of calibration. One or more resistors in 50 and 500 volt ac attenuator has shifted in value.	Recalibrate per paragraph 1-85; dc calibration is not necessary. Recalibrate per paragraph 1-85; dc calibration is not necessary. Recheck after 48 hours. Replacement of resistor is necessary if attenuator does not remain stable, or if calibration is not possible.
Measurements are out of tolerance on 500 volt ac range only, Model 803B.	Out of calibration. One or more resistors in 500 volt ac attenuator has shifed in value.	Recalibrate per paragraphs 1-93 and 1-98; dc calibration is not necessary. Recalibrate per paragraphs 1-93 and 1-98; dc calibration is not necessary. Recheck calibration after 48 hours. Replacement of resistor is necessary if attenuator does not remain stable, or calibration is not possible.
Measurements are out of tolerance on 50 volt ac range only, Model 803B.	Out of calibration. One or more resistors in 50 volt ac attenuator has shifted in value.	Recalibrate per paragraphs 1-93 and 1-100; dc calibration is not necessary. Recalibrate per paragraphs 1-93 and 1-100; dc calibration is not necessary. Recheck after 48 hours. Replacement of resistor is necessary if attenuator does not remain stable or if calibration is not possible.
Measurements out of tolerance on all ac ranges.	Out of calibration. V501 or V502 faulty.	Recalibrate per paragraph 1-85. Check V501 and V502 by replacement.

Figure 1-12. Troubleshooting (Sheet 2 of 3)

SYMPTOM	PROBABLE CAUSE	REMEDY
Measurements out of tolerance at a specific frequency, Model 803.	Out of calibration. Faulty frequency compensation capacitor.	Recalibrate per paragraph 1-85. Locate faulty capacitor and replace. If trouble occurs on all ranges, check C504. If trouble occurs on 50 or 500 volt range, check C501 and C502. If trouble occurs on 500, and 5 volt range, check C521. If trouble occurs on 0.5 and 50 volt range check C519 and C520.
Measurements out of tolerance at a specific frequency, Model 803B.	Out of calibration. Faulty frequency compensation capacitor.	Recalibrate per paragraphs 1-93 through 1-101. Locate faulty capacitor and replace. If trouble occurs on all ranges, check C504. If trouble occurs on 500 volt range only, check C523, C524, and C525. If trouble occurs on 50 volt range only, check C501 and C502. If trouble occurs on 500, 50, and 5 volt range, check C521. If trouble occurs on 0.5 volt range check C519 and C520.

Figure 1-12. Troubleshooting (Sheet 3 of 3)

Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V101, 6BQ5	No Conn.	495	500	Heater voltage 6.3 volts ac		No Conn.	680 to 730	No Conn.	680 to 730
V102, OG3	85	0	Int. Conn.	0	85	Int. Conn.	0	No Pin	No Pin
V104, 12AX7	217	84	86	Heater voltage 5.9 volts dc		217	84	86	See Pin 4 & 5
V105, 12AX7	495	217	220	Heater voltage 6.3 volts ac		500	217	220	
V202, EF-86/6267	35	0	1.2	Heater voltage 6 volts ac		50	0	1.2	-
V203, 6AW8	0.9	-	100	Heater voltage 6.3 volts ac		0.7	-	20	40
V204, OA2	150	0	Int. Conn.	0	150	Int. Conn.	0	No Pin	No Pin
V501, 6EJ7	1.3	-	1.3	Heater voltage 5.9 volts dc		0	149	93	1.3
V502, 6AW8	28	-	197			1.8	-	103	70

This chart is to be used under the following conditions: (a) RANGE switch set to 500; (b) NULL switch set to VTVM: (c) all voltage readout dials set to zero; (d) line voltage at 115/230 volts, 50 - 60 cycles; and (e) all measurements made with a VTVM from negative binding post to specified terminal.

Figure 1-13. Tube Voltage Chart

1-75. CALIBRATION

1-76. Calibration should be accomplished in a draft free area with ambient temperature of 72 (±3°) F for maximum accuracy under laboratory operating condition. The instrument may be calibrated either in or out of its case.

1-77. The calibration procedure is divided into two parts: DC Differential Voltmeter calibration (paragraph 1-78) and AC to DC Converter calibration (paragraph 1-85). The DC Differential Voltmeter calibration must be performed prior to AC to DC Converter calibration. The recommended equipment and the specifications required for DC Differential Voltmeter calibration and AC to DC Converter calibration are listed in figure 1-14. All controls may be located with the aid of figure 1-15 (Model 803) or figure 1-16 (Model 803B). The recommended calibration setup is shown in figure 1-17 for DC Differential Voltmeter calibration and in figure 1-18 for AC to DC Converter calibration.

	DC CALIBRATION:	AC CALIBRATION:
RECOMMENDED EQUIPMENT	Fluke 301C or 301E Power Supply Eppley Standard Cell 100A Leeds and Northrup 2430A Galvanometer Electro Scientific Industries Special Precision Voltage Divider X194 Any single pole push button switch with fine silver contacts Any double pole push button switch with fine silver contacts Any 5.6 (±10%) Ω resistor Any 56 (±10%) Ω resistor	Any Fluke Model 800 series Differential Voltmeter Fluke 301C or 301E Power Supply Elin VC - 555A Oscillator Fluke 540A Transfer Standard
SPECIFICATIONS REQUIRED	The equipment used must provide 500, 50, 5, and 0.5 volts with an accuracy of 0.01%.	The equipment used must provide 500, 50, 5, and 0.5 volts AC at 400 cycles and 10 kilocycles with an accuracy of at least 0.05% and with less than 0.1% total harmonic distortion.

Figure 1-14. Calibration Equipment

1-78. DC DIFFERENTIAL VOLTMETER CALIBRATION. The Bureau of Standards will certify the Eppley 100A cell used in the calibration setup to only 0.01%. However, the standard cell may be maintained to 0.002% if treated with care and not subjected to sudden temperature changes. For reasonable certainty of 0.002% cell accuracy, the certified value should be known to six places. Since the ESI voltage divider is accurate within 0.005%, the overall dc calibration system accuracy is between 0.% and 0.007%.

1-79. Preliminary Calibration Procedure.

a. Set meter to zero with adjustment screw on front of meter case.

b. Set controls as follows:

MODEL 803

OPERATE-ZERO-CAL	OPERATE
AC-DC	DC
RANGE	500
NULL	VTVM
all voltage read-out dials	0 (zero)

MODEL 803B

AC-dc polarity	+ (positive)
RANGE	500
NULL	VTVM
all voltage read-out dials	0 (zero)

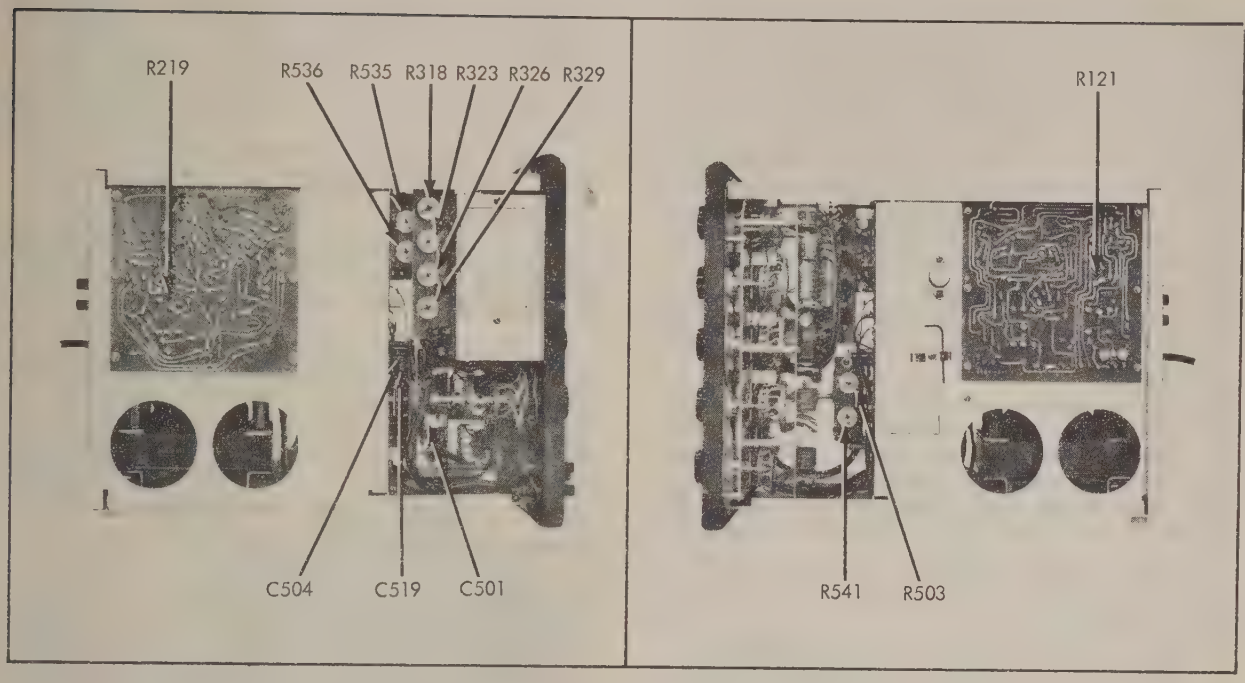


Figure 1-15. Adjustment Locations, Model 803

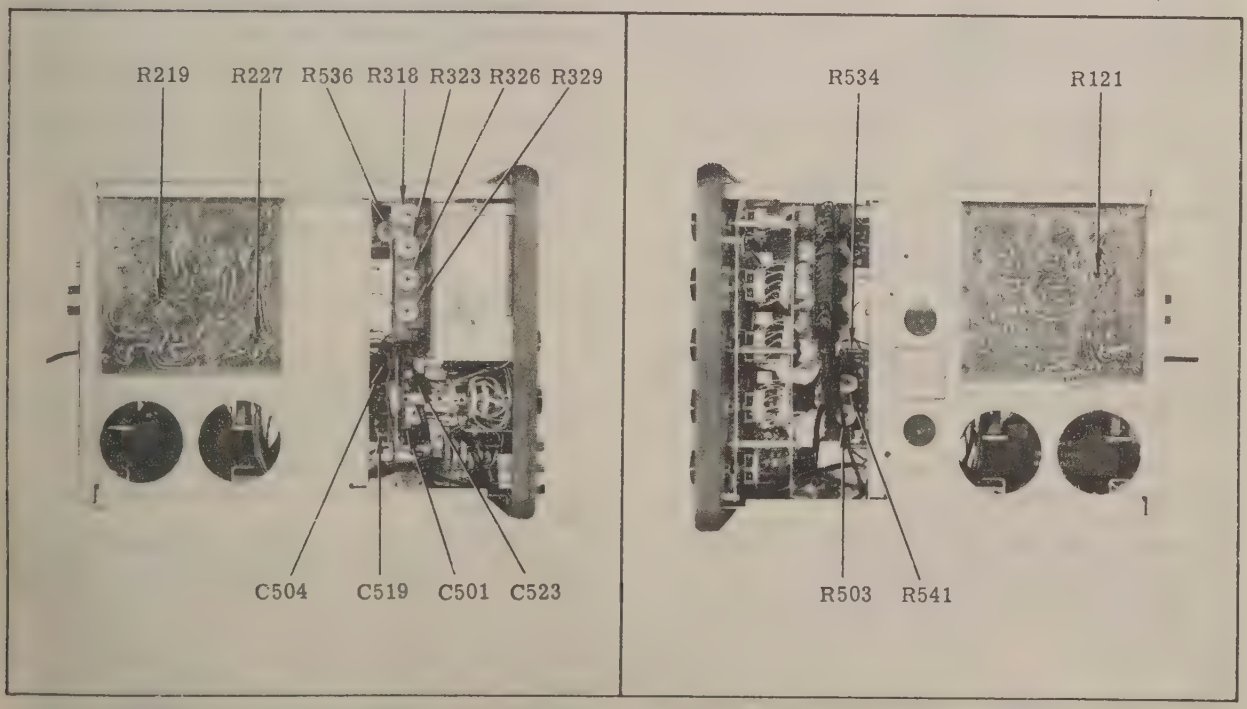


Figure 1-16. Adjustment Locations, Model 803B

c. Set power switch to ON and allow voltmeter to warmup to equilibrium temperature (about 1/2 hour).
d. Set up necessary equipment to provide dc voltages of 500, 50, 5, and 0.5 volts dc with an accuracy of 0.01%. Proceed as follows: connect the equipment as shown in figure 1-17; turn on all test equipment and allow it to warmup to equilibrium temperature (about 1/2 hour); set proper standard cell voltage on ESI divider; apply 500 volts dc into divider from power supply; set ESI divider to 500 and zero galvanometer by varying output of power supply while depressing coarse and then coarse and fine pushbutton switch; voltages of 500, 50, 5, and 0.5 volts dc (±0.01%) are made available at output posts by merely changing position of voltage selector switch on voltage divider.
e. If instrument is to be calibrated out of its cabinet, connect chassis ground binding post to line ground.
f. If instrument is to be calibrated in its cabinet, use an insulated screwdriver to prevent shorting control to chassis ground. The instrument must be partly slid out of the cabinet to reach controls at the front.

1-80. Null Detector Calibration, Model 803.
a. Perform preliminary calibration procedure as stated in paragraph 1-79.
b. Set OPERATE-ZERO-CAL switch to ZERO.
c. Adjust ZERO control until meter indicates zero.
d. Set OPERATE-ZERO-CAL switch to OPERATE.
e. Apply 500 vdc (±0.01%) to voltmeter.
f. Adjust VTVM GAIN ADJ control R219 for full scale deflection.

1-81. 500 VDC Reference Supply Calibration, Model 803.
a. Perform preliminary calibration procedure as stated in paragraph 1-79.
b. Center CAL control at its center of rotation.
c. Set controls as follows:

RANGE	500
NULL	10
voltage readout dials	499.910

d. Apply 500 vdc (±0.01%) to voltmeter.
e. Adjust 500V ADJ control R121 for a null.
f. Set NULL switch to 0.1 volt.
g. Null meter by adjusting CAL control.
h. Advance OPERATE-ZERO-CAL switch against spring tension to CAL and null meter by adjusting REF-CAL ADJ control R318.
i. Set OPERATE-ZERO-CAL switch to OPERATE.

1-82. Null Detector Calibration, Model 803B.
a. Perform preliminary calibration procedure as stated in paragraph 1-79.
b. Adjust null detector ZERO ADJ control R227 until meter indicates zero.
c. Apply 500 volts DC (±0.01%) to voltmeter.
d. Adjust VTVM GAIN ADJ control R219 for full scale deflection.

1-83. 500 VDC Reference Supply Calibration, Model 803B.
a. Perform preliminary calibration procedure as stated in paragraph 1-79.
b. Center CALIBRATE control at its center of rotation.
c. Set NULL switch to 10 and voltage readout dials to 499.910.
d. Apply 500 volts DC (±0.01%) to voltmeter.
e. Adjust 500V ADJ control R121 for a null.
f. Set NULL switch to 0.1 volt.
g. Null meter by adjusting CALIBRATE control.
h. Advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE and null meter by adjusting REF CAL ADJ control R318.

1-84. Range Divider Calibration
a. Perform preliminary calibration procedure as stated in paragraph 1-79.
b. Set controls as follows:

RANGE	50
NULL	0.01
voltage readout dials	49.9910

c. Apply 50 vdc (±0.01%) to voltmeter.
d. Null meter by adjusting 50V ADJ control R323.
e. Set RANGE switch to 5 volts.
f. Apply 5 vdc (±0.01%) to voltmeter.
g. Null meter by adjusting 5V ADJ control R326.
h. Set RANGE switch to 0.5 volt.
i. Apply 0.5 vdc (±0.01%) to voltmeter.
j. Null meter by adjusting 0.5V ADJ control R329.

1-85. AC TO DC CONVERTER CALIBRATION. The DC Differential Voltmeter section must be within specification before the AC to DC Converter can be accurately calibrated. The AC to DC Converter must be calibrated in the following order.

1-86. Preliminary Calibration Procedure, Model 803.
a. Perform DC Differential Voltmeter calibration as stated in paragraphs 1-79 through 1-84.
b. Set controls as follows:

OPERATE-ZERO-CAL	OPERATE
AC-DC	AC
RANGE	5
NULL	0.01
All voltage readout dials	0 (zero)

c. Short input binding posts and adjust AC ZERO ADJ control R535 until meter indicates zero.
d. Remove short from input binding posts.
e. Set RANGE switch to 500 and voltage readout dials to 499.910.
f. Set up the necessary equipment to provide ac voltages of 500, 50, 5, and 0.5 vac with an accuracy of at least ±0.05% at frequencies of 400 cycles and 10 kilocycles, with less than 0.1% total harmonic distortion. Proceed as follows: connect equipment as shown in figure 1-18; turn on all test equipment and allow to warmup to equilibrium temperature (about 1/2 hour); adjust dc power supply voltage until differential voltmeter indicates rms value of ac volt-

age required; apply output of dc supply to 540A and null galvanometer by adjusting internal reference supply voltage; apply output of ac oscillator to 540A and null galvanometer by adjusting ac oscillator voltage; output of the Elin Oscillator now equals the required ac voltage.

1-87. 0.5 VAC Converter Gain Adjustment, Model 803.

a. Set RANGE switch to 0.5.
b. Apply 0.5 vac at 400 cycles to voltmeter.
c. Adjust 0.5V GAIN ADJ control R536 until meter needle is between 0 and + 200 microvolts (two major divisions).

1-88. 5 VAC Converter Gain Adjustment, Model 803.

a. Set Range switch to 5.
b. Apply 5 vac at 400 cycles to voltmeter.
c. Adjust 5V GAIN ADJ control R541 until meter needle is between 0 and + 2 millivolts (two major divisions).

1-89. 5 VAC High Frequency Adjustment, Model 803.

a. Apply 5 vac at 10 kilocycles to voltmeter.
b. Adjust 5V HF TRIM control C504 until meter needle is between + 1 and + 3 millivolts (one and three major divisions).

1-90. 50 and 500 VAC Attenuator Adjustment, Model 803.

a. Set RANGE switch to 50.
b. Apply 50 vac at 400 cycles to voltmeter.
c. Adjust 50V and 500V ATTENUATOR control R503 until meter needle is between 0 and + 20 millivolts (two major divisions).
d. Set RANGE switch to 500.
e. Apply 500 vac at 400 cycles to voltmeter.
f. If meter needle is not between -200 and + 600 millivolts (minus two and plus six major divisions), repeat procedure from paragraph 1-88.

1-91. 50 and 500 VAC High Frequency Adjustment, Model 803.

a. Apply 500 vac at 10 kilocycles to voltmeter.
b. Adjust 50V and 500V HF TRIM control C501 until meter needle is between 100 and 300 millivolts (one and three major divisions).

1-92. 0.5 VAC High Frequency Adjustment, Model 803.

a. Set RANGE switch to 50.
b. Apply 50 vac at 10 kilocycles to voltmeter.
c. Adjust 0.5V HF TRIM control C519 until meter needle is between + 10 and + 30 millivolts (one and three major divisions).

1-93. Preliminary Calibration Procedure, Model 803B.

a. Perform DC Differential Voltmeter calibration as stated in paragraphs 1-79 through 1-84.
b. Set controls as follows:

RANGE	500
NULL	0.01
AC-DC polarity	AC
voltage read-out dials	499.910

c. Set up the necessary equipment to provide 500, 50, 5, and 0.5 volts ac with an accuracy of at least ±0.05% at frequencies of 400 cycles and 10 kilocycles, with less than 0.1% total harmonic distortion. Proceed as follows: connect equipment as shown in figure 1-18; turn on all test equipment and allow to warm up to equilibrium temperature (about 1/2 hour); adjust dc power supply voltage until differential voltmeter indicates rms value of ac voltage required; apply output of dc supply to 540A and null galvanometer by adjusting internal reference supply voltage; apply output of ac oscillator to 540A and null galvanometer by adjusting ac oscillator voltage; the output of the Elin Oscillator now equals the required ac voltage.

1-94. 0.5 VAC Converter Gain Adjustment, Model 803B.

a. Set RANGE switch to 0.5.
b. Apply 0.5 vac at 400 cycles to voltmeter.
c. Adjust 0.5 VAC GAIN ADJ control R536 until the meter needle is within ±50 microvolts (1/2 major division) of null.

1-95. 5 VAC Converter Gain Adjustment, Model 803B.

a. Set RANGE switch to 5.
b. Apply 5 vac at 400 cycles to voltmeter.
c. Adjust 5 VAC GAIN ADJ control R541 for a null.

1-96. 5 VAC High Frequency Adjustment, Model 803B.

a. Apply 5 vac at 10 kilocycles to voltmeter.
b. Adjust 5 VAC HF TRIM control C504 for a null.

1-97. 0.5 VAC High Frequency Adjustment, Model 803B.

a. Set RANGE switch to 0.5.
b. Apply 0.5 vac at 10 kilocycles to voltmeter.
c. Adjust 0.5 VAC HF TRIM control C519 for a null.

1-98. 500 VAC Attenuator Adjustment, Model 803B.

a. Set RANGE switch to 500.
b. Apply 500 vac at 400 cycles to voltmeter.
c. Adjust 500 VAC ATTENUATOR control R534 for a null.

1-99. 500 VAC High Frequency Adjustment, Model 803B.

a. Apply 500 vac at 10 kilocycles to voltmeter.
b. Adjust 500 VAC HF TRIM control C523 for a null.

1-100. 50 VAC Attenuator Adjustment, Model 803B.

a. Set RANGE switch to 50.
b. Apply 50 vac at 400 cycles to voltmeter.
c. Adjust 50 VAC ATTENUATOR control R503 for a null.

1-101. 50 VAC High Frequency Adjustment, Model 803B.

a. Apply 50 vac at 10 kilocycles to voltmeter.
b. Adjust 50 VAC HF TRIM control C501 for a null.

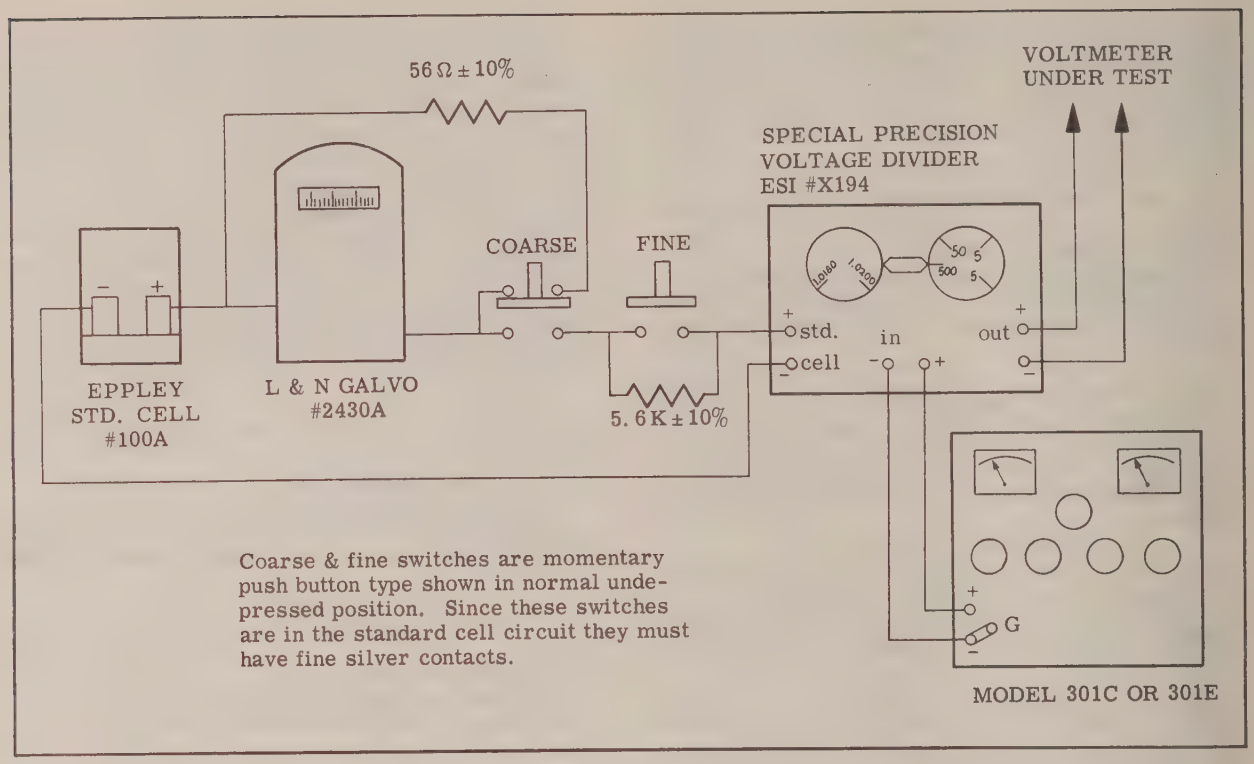

56Ω ± 10%
VOLTMETER UNDER TEST
SPECIAL PRECISION VOLTAGE DIVIDER ESI #X194
COARSE
FINE
EPPLEY STD. CELL #100A
L & N GALVO #2430A
5.6K ± 10%
std.
cell
in
out
G
MODEL 301C OR 301E
Coarse & fine switches are momentary push button type shown in normal undepressed position. Since these switches are in the standard cell circuit they must have fine silver contacts.

Figure 1-17. DC Differential Voltmeter Calibration Set-up

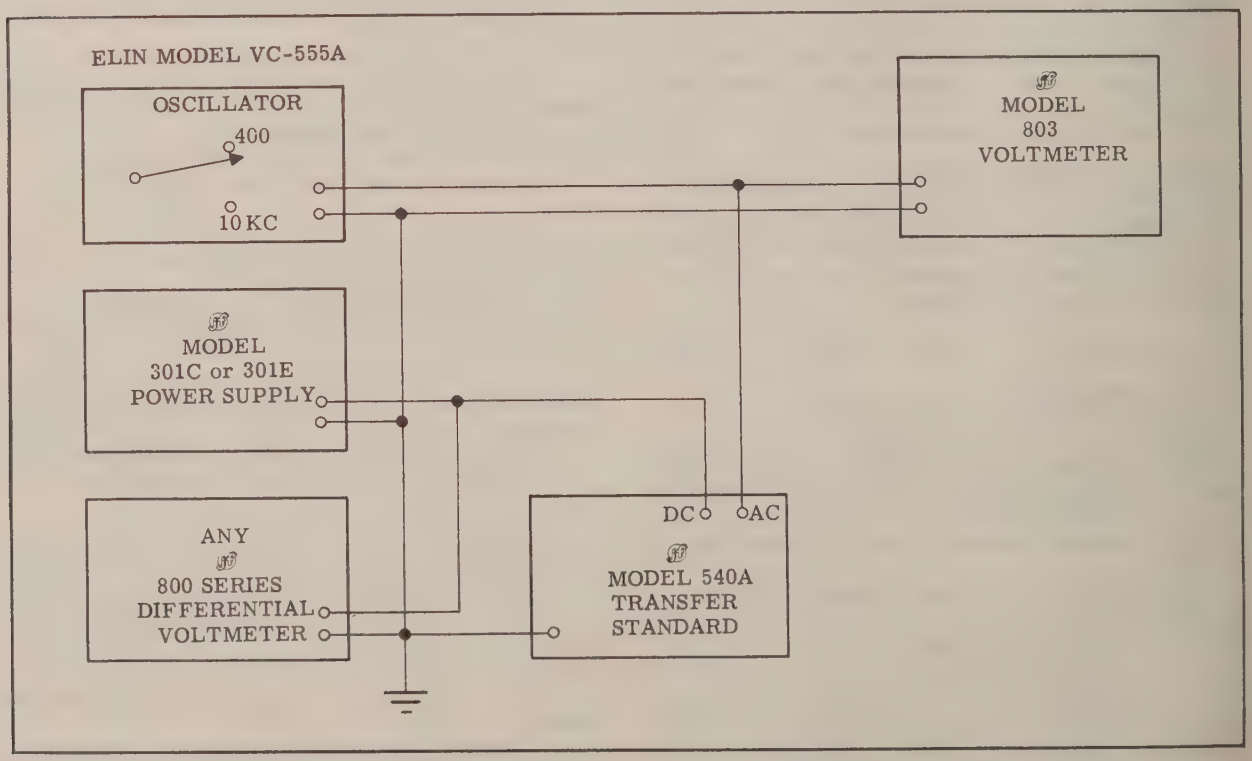
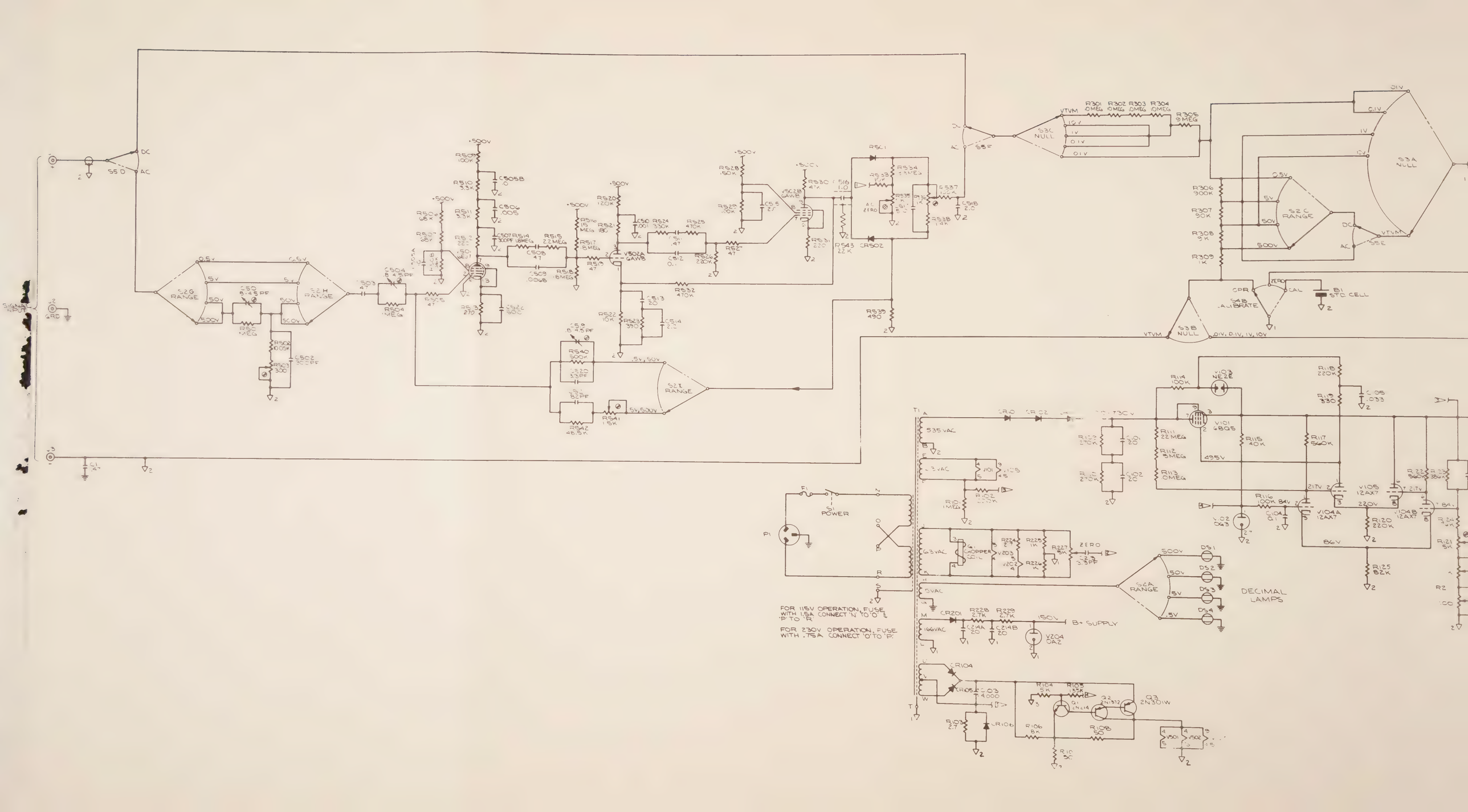


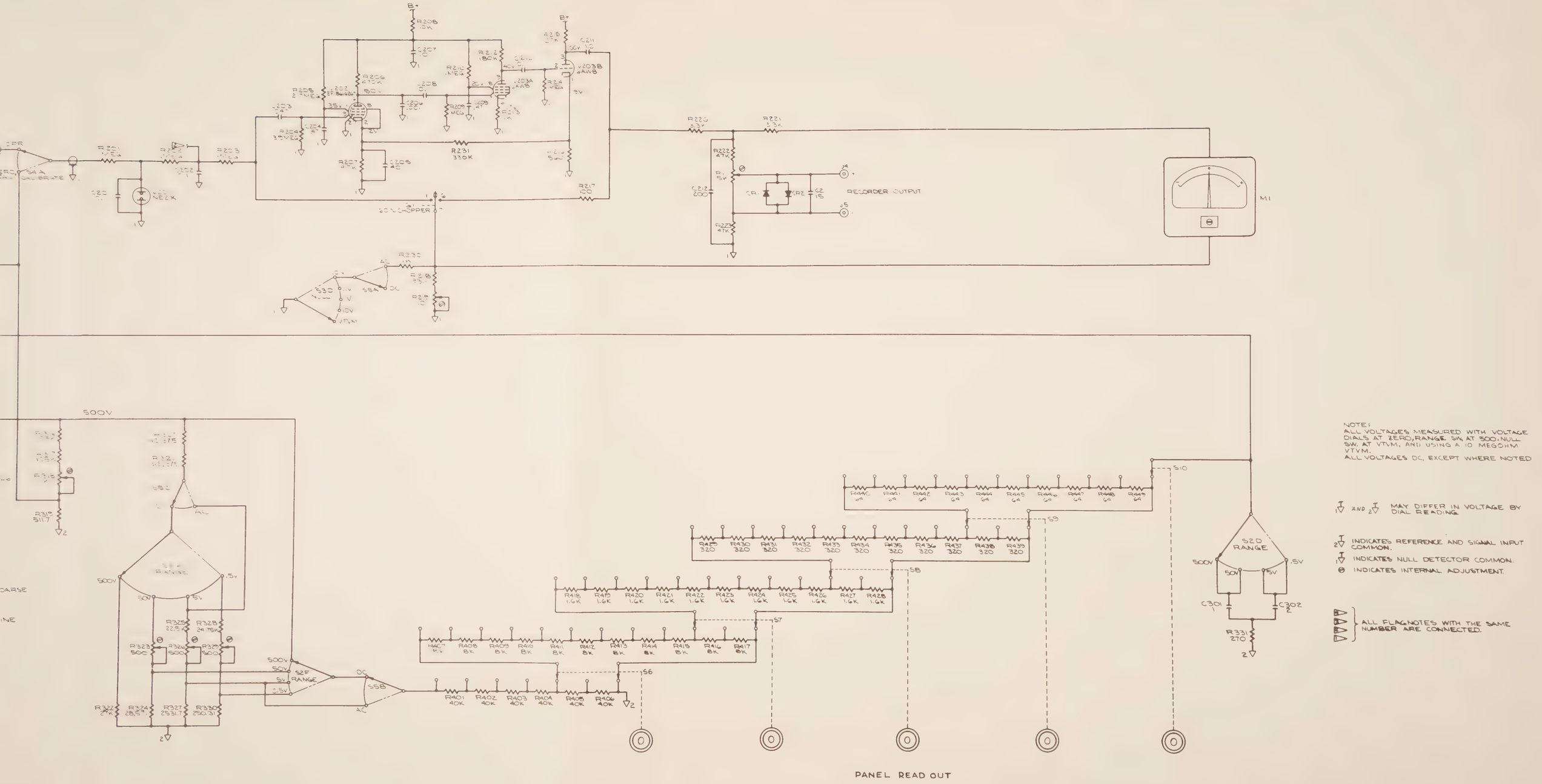
Figure 1-18. AC to DC Converter Calibration Set-up

Component Designations		Component Locations	
B - Standard cell	M - Meter	1 - 99	Final Assembly
C - Capacitor	P - Plug	101 - 199	Reference Supply Board Assembly
CR - Diode	Q - Transistor	201 - 299	Null Detector Board Assembly
DS - Indicator	R - Resistor	301 - 399	Range Resistor Board Assembly
F - Fuse	S - Switch	401 - 499	Kelvin-Varley Resistor Board Assembly
G - Electromechanical chopper	T - Transformer	501 - 599	AC to DC Converter Assembly
J - Jack	V - Electron tube		

All circuit components are identified by a reference designation composed of letters and numbers. The letters identify the class to which a part belongs such as resistors, capacitors, electron tubes, etc. The numbers identify the specific part within that class and the assembly on which it is located.

Figure 1-19. Legend of Reference Designations


S5 D
DC
AC
S2G RANGE
S2H RANGE
S2I RANGE
S2A RANGE
S2C RANGE
S3A NULL
S3B NULL
S3C NULL
S3E
S4B CALIBRATE
ZERO
CAL
B1 STD CELL
VTVM
DECIMAL LAMPS
S1 POWER
CHOPPER
ZERO
B+ SUPPLY
FOR 115V OPERATION, FUSE WITH 1.5A CONNECT 'N' TO 'O' & 'P' TO 'R'
FOR 230V OPERATION, FUSE WITH .75A CONNECT 'O' TO 'P'.



NOTE:
ALL VOLTAGES MEASURED WITH VOLTAGE DIALS AT ZERO, RANGE SW. AT 500, NULL SW. AT VTVM, AND USING A 10 MEGOHM VTVM.
ALL VOLTAGES DC, EXCEPT WHERE NOTED

1▽ AND 2▽ MAY DIFFER IN VOLTAGE BY DIAL READING.

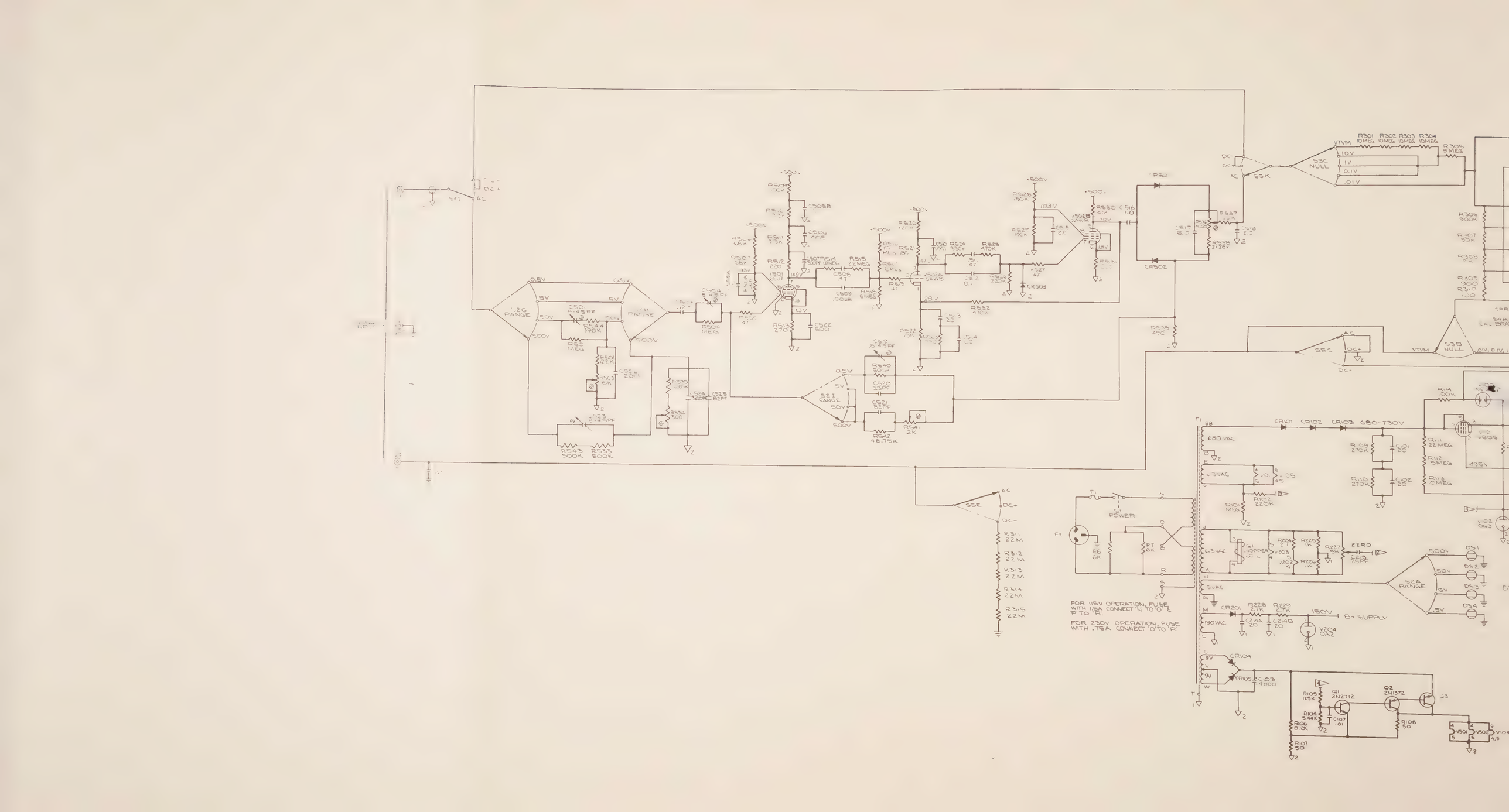
2▽ INDICATES REFERENCE AND SIGNAL INPUT COMMON.

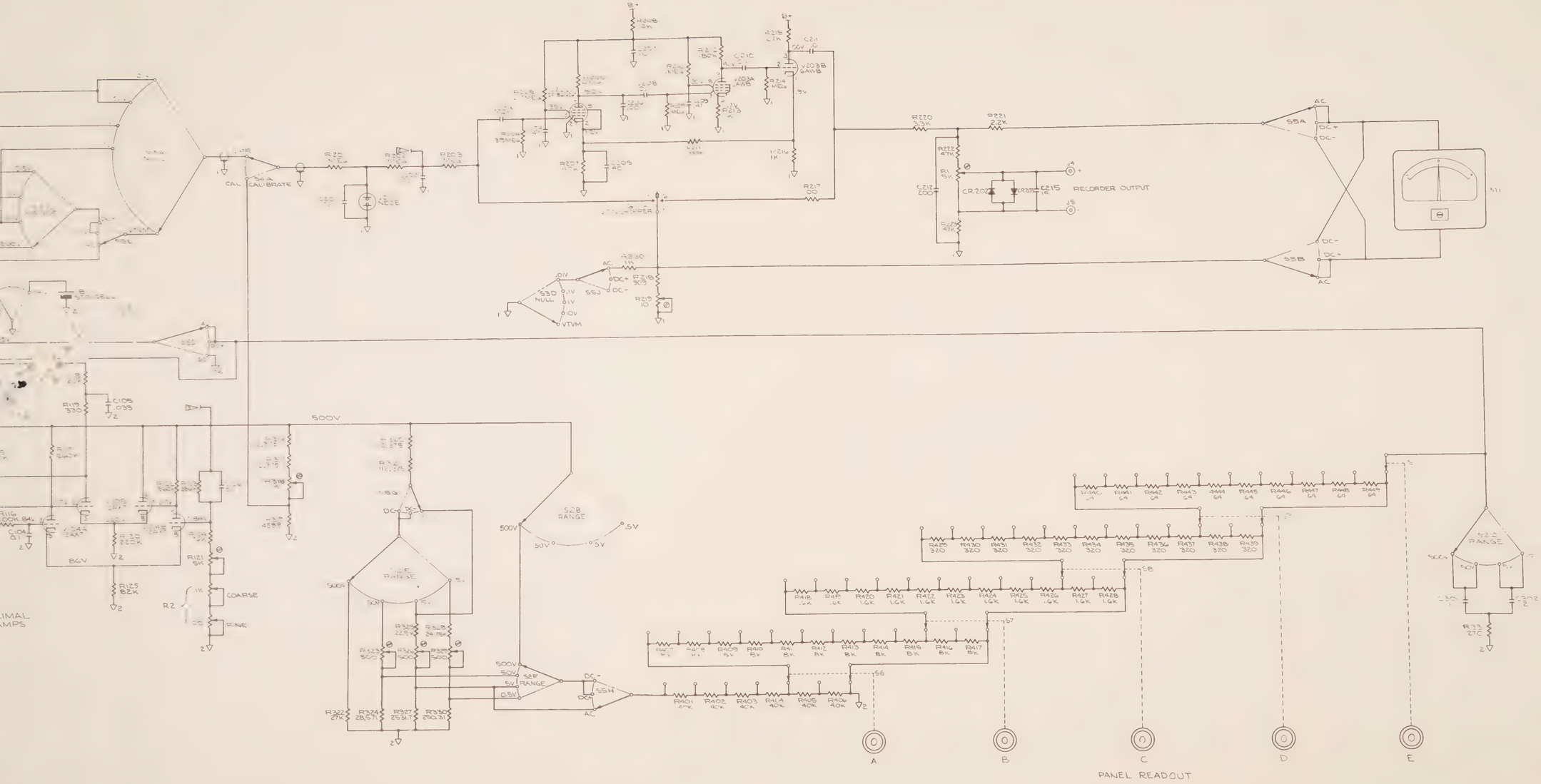
1▽ INDICATES NULL DETECTOR COMMON.

⊖ INDICATES INTERNAL ADJUSTMENT.

ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED.

Figure 1-20. Schematic Diagram, Model 803


DC+
AC
.2V RANGE
.5V
1V
5V
10V
50V
100V
500V
M RANGE
S2B RANGE
S2A RANGE
S2C RANGE
S2D RANGE
S2E RANGE
S2F RANGE
S2G RANGE
S2H RANGE
S2I RANGE
S3A
S3B
S3C
S3D
S3E
S3F
S3G
S3H
S3I
S4A
S4B
S4C
S4D
S4E
S4F
S4G
S4H
S4I
S5A
S5B
S5C
S5D
S5E
S5F
S5G
S5H
S5I
S6A
S6B
S6C
S6D
S6E
S6F
S6G
S6H
S6I



NOTES

1. All voltage measurements shown are taken under the following conditions:
   (a) RANGE switch set to 500.
   (b) NULL switch set to VTVM.
   (c) All voltage readout dials set to zero.
   (d) AC-DC polarity switch set to +.
   (e) Line voltage at 115/230 volts, 50-60 cycles.
   (f) All measurements made with a VTVM (10 megohms input resistance) to the negative binding post.
2. All voltages are DC unless otherwise indicated.
3. $\downarrow_{V_1}$ Indicates null detector common.
4. $\downarrow_{V_2}$ Indicates reference supply and converter common.
5. $\downarrow_{V_1}$ and $\downarrow_{V_2}$ may differ in voltage by amount indicated on voltage readout dials.
6. ▷ All flagnotes with the same number are connected.
7. ⊖ Indicates internal adjustment.
8. Unless otherwise indicated, resistances are in ohms and capacitances are in microfarads.
9. On some Null Detector Printed Circuit Boards, C215, CR202, and CR203 have been designated as C2, CR1, and CR2.

Figure 1-21. Schematic Diagram, Model 803B

SECTION II

PARTS BREAKDOWN MODEL 803

2-1. INTRODUCTION

a. This parts breakdown provides positive identification of parts necessary for support of the Model 803 AC/DC Differential Voltmeter. Sufficient information necessary to order any needed replacements is also included.

b. Seven figures in this section illustrate the final assembly of the 803 and various assemblies and subassemblies. Each figure is accompanied by a corresponding parts list, the tabular columns of which are Figure and Index Number, Part Number, Description, Quantity Per Assembly, and Reference Designation.

c. The first entry in the Figure and Index Number column of each parts list is a figure number only, with no reference number. This figure number refers to the corresponding illustration. Succeeding dash numbers are reference numbers on the corresponding illustration with leader lines and arrows to the specific parts.

d. Entries in the Part Number column are part numbers assigned by the company that controls the design of the part. Parts not illustrated are designated by an asterisk following the part number.

e. The Description column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and attached parts relationship. The manufacturer's code number of the company that controls the design of the part follows the nomenclature of the part. The manufacturer's code numbers are from the Federal Cataloging Handbook, H4-1. The John Fluke Part number assigned to vendor parts follows the manufacturer's code number.

f. The number in the Quantity Per Assembly column indicates the total quantity of the part used on the assembly below which the part is listed. "Ref" indicates that the assembly is listed under the next higher assembly and is cross-referenced by figure and index number in the Description column. The quantity per assembly is given in the referenced figure.

g. Entries in the Reference Designation column indicate the reference designations used on the schematic diagram.

2-2. FEDERAL SUPPLY CODE FOR MANUFACTURERS

Code	Manufacturer
00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Cleveland, Ohio
01295	Texas Instruments, Inc. Transistor Products Div. Dallas, Texas
03614	Bussmann Fuse Div. of Mc Graw-Edison Co. Los Angeles, Calif.
03877	Transitron Electronic Corp. Wakefield, Mass.
03980	Muirhead Instruments, Inc. New York, New York
04009	Arrow Hart and Hegeman Electric Company Hartford, Conn.
04061	Allen-Bradley Co. Chicago, Ill.
04645	Kurz-Kasch, Inc. Chicago, Illinois
07115	Corning Glass Works Electronic Components Dept. Bradford, Pa.
12136	Philadelphia Handle Co. Camden, New Jersey
12697	Clarostat Mfg. Co., Inc. Dover, New Hampshire

Code	Manufacturer
15909	Daven Company Livingston, New Jersey
24655	General Radio Co. West Concord, Mass.
33173	General Electric Co. Receiving Tube Dept. of Electronic Components Div. of Electronic, Atomic, and Defense Systems Group Owensboro, Kentucky
49671	Radio Corp. of America New York, New York
56289	Sprague Electric Co. North Adams, Mass.
71450	CTS Corp. Elkart, Indiana
71590	Centralab Div. of Globe Union, Inc. Milwaukee, Wisconsin
72354	Fast, John E., & Co. Chicago, Illinois
73445	Amperex Electronic Co. Div. of North American Philips Co., Inc. Hicksville, New York
73899	JFD Electronics Corp. Brooklyn, New York
81483	Industrial Rectifier Corp. El Segundo, Calif.
82376	Astron Company East Newark, N. J.
84411	Good-All Electric Mfg. Co. Ogallala, Nebraska
89536	Fluke, John, Mfg. Co., Inc. Seattle, Washington
89730	General Electric Co. Newark Lamp Works of Lamp Div. of Consumer Products Group Newark, New Jersey
93332	Sylvania Electric Products, Inc. Semiconductor Division Woburn, Mass.
98388	Accurate Sales Co., Inc. Culver City, Calif.
98743	James Vibrapower Corp. Chicago, Illinois
99515	Marshal Industries, Electron Prod. Div. Pasadena, Calif.

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-1-	803B-501	MODEL 803 AC/DC DIFFERENTIAL VOLTMETER Final Assembly (89536)	Ref	
-1	803B-407	. FRONT PANEL ASSEMBLY (see figure 2-2) (89536)	1	
-2	803B-401	. REFERENCE SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY (see figure 2-3)(89536)	1	
-3	803B-402	. NULL DETECTOR PRINTED CIRCUIT BOARD ASSEMBLY (see figure 2-4)(89536)	1	
-4	803B-403	. RANGE RESISTOR PRINTED CIRCUIT BOARD ASSEMBLY (see figure 2-5)(89536)	1	
-5	801B-403	. KELVIN-VARLEY RESISTOR PRINTED CIRCUIT BOARD ASSEMBLY (see figure 2-6) (89536)	1	
-6	803B-434	. CONVERTER/AC RANGE SWITCH ASSEMBLY (see figure 2-7)(89536)	1	
-7	801B-651	. TRANSFORMER, power (89536)	1	T1
-8	2N301W	. TRANSISTOR, germanium, PNP, 2N301W (98925)	1	Q3
-9	938-C	. BINDING POST, black (24655)(X219)	2	J4, J5
-10	938B-R	. INSULATOR, binding post, red (24655)(X217)	4	
-11	MDL-1.5	. FUSE, 1.5 ampere, slow-blowing (03614) (F1-1/2A)	1	F1
-12	CM11406	. RESISTOR, variable, wirewound, 5K ±10%, 2W (12697)(P5KA)	1	R1
-13	TE1089	. CAPACITOR, electrolytic, 15 uf -10/+150%, 6V (56289)(CE36)	1	C2
-14	2E4	. DIODE, silicon, 300 ma, 400 PIV (81483)	2	CR1, CR2
-15	803B-271*	. CASE ASSEMBLY (89536)	1	
-16	BH2097*	. . FOOT, rubber (98388)(X224)	4	
-17	919-415-173*	. . HANDLE, flexible black vinyl, 5-1/2" (12136)(X373)	1	
-18	X27H*	. CORD, power (89536)	1	

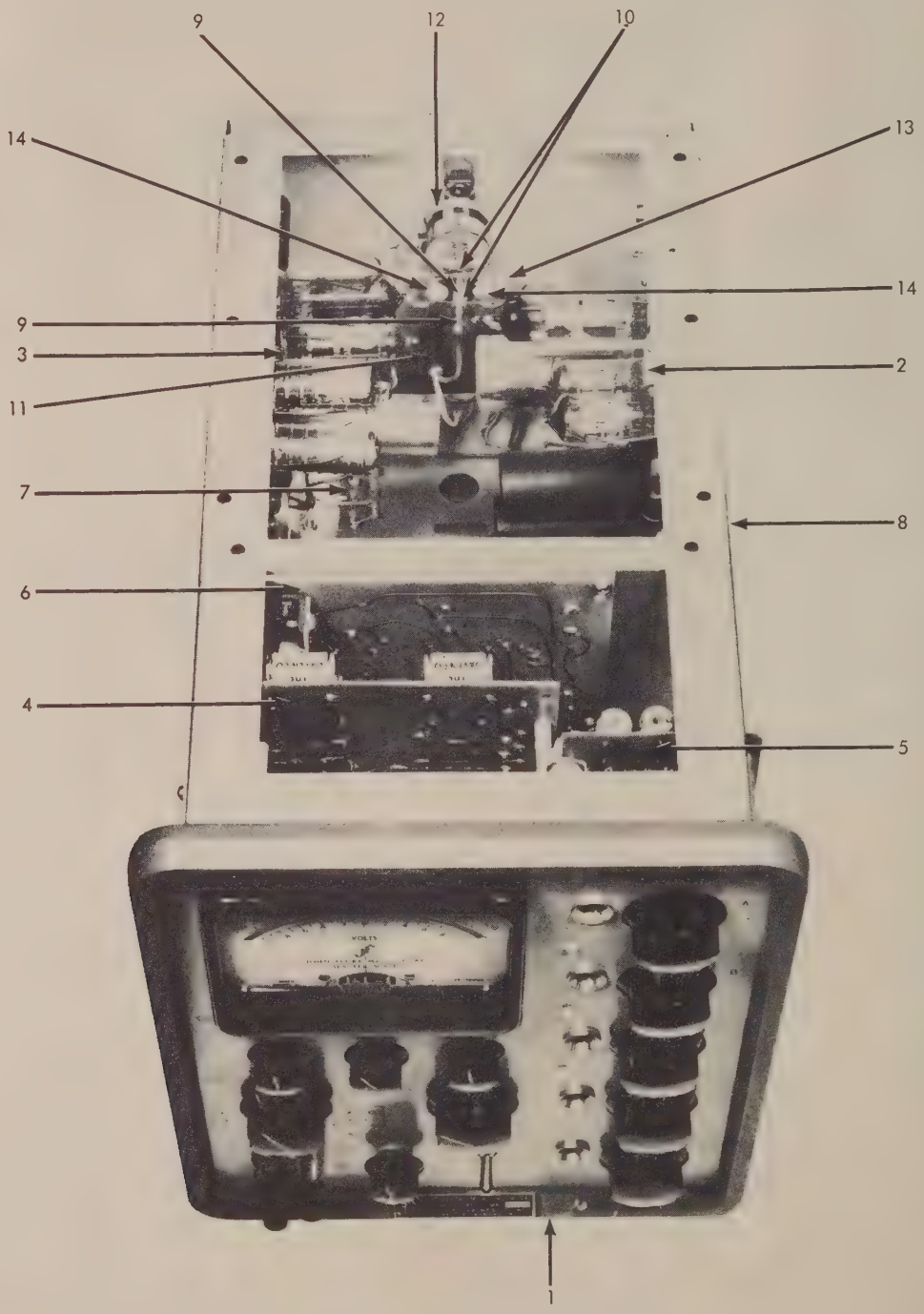
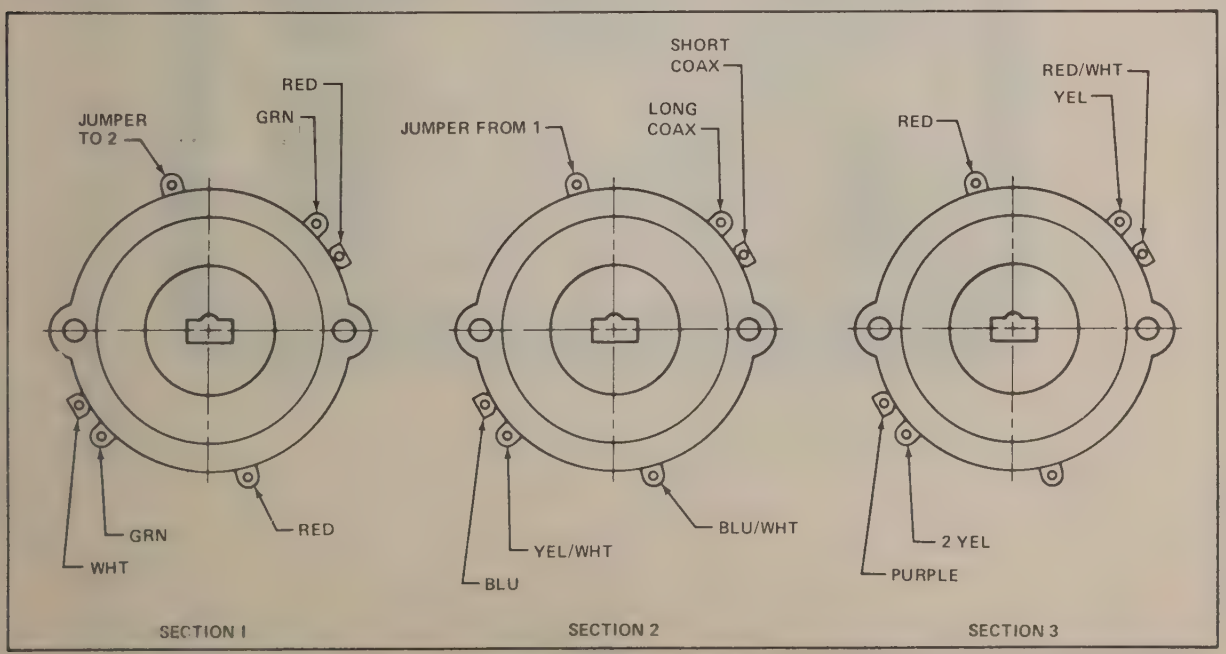


Figure 2-1. Final Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-2-	803B-407	FRONT PANEL ASSEMBLY (see figure 2-1-1 for next higher assembly)	Ref	
-1	938-C	. BINDING POST, black (24655)(X219)	3	J1, J2, J3
-2	938B-R	. INSULATOR, binding post, red (24655)(X217) .	2	
-3	938B-B	. INSULATOR, binding post, black (24655)(X218)	2	
-4	938-F	. SPACER, binding post (24655)(X220)	1	
-5	938L*	. SHORTING LINK (24655)(X221)	1	
-6	S-647-3L	. KNOB, 1 inch with pointer (04645)(X231)	4	
-7	S-642-3-BB	. KNOB, 1-1/2 inch without pointer (04645)(X207)	5	
-8	S-653-3-BB-L	. KNOB, 1-1/2 inch with pointer (04645)(X234) .	1	
-9	S-653-3L-BB	. KNOB, 1-1/2 inch with index line (04645) (X2085)	1	
-10	D3	. DIAL PLATES, voltage (89536)	5	
-11	D-845C	. VOLTAGE STANDARD (03980)(X223)	1	B1
-12	D6-474	. CAPACITOR, plastic, 0.47 uf ±20%, 600V (99515)(CP25)	1	C1
-13	M54	. METER, 100-0-100 microamp (89536)	1	M1
-14	20994-LH	. SWITCH, power (04009)(ST5)	1	S1
-15	803B-812	. SWITCH, range, DC section (89536)	1	S2
-16	803B-816	. SWITCH, null (89536)	1	S3
-17	5105-125138	. SWITCH, operate-zero-cal (89536)	1	S4
-18	803B-815	. SWITCH, AC-DC (R/B5105-120691) (89536) See wiring drawing below	1	S5
-19	801B-819	. SWITCH, voltage dial A (89536)	1	S6
-20	801B-820	. SWITCH, voltage dials B, C, and D (89536) . .	3	S7, S8, S9
-21	801B-821	. SWITCH, voltage dial E (89536)	1	S10
-22	Type 47	. LIGHT, decimal indicator (33173)(X2051) . . .	4	DS1, DS2, DS3, DS4
-23	2-252	. RESISTOR, variable, dual section wirewound, 1K ±10% and 100Ω ±10%, 2W (71450)(P1KD) . .	1	R2
-24	CM11406	. RESISTOR, variable, wirewound, 5K ±10%, 2W (12697)(P5KA)	1	R227



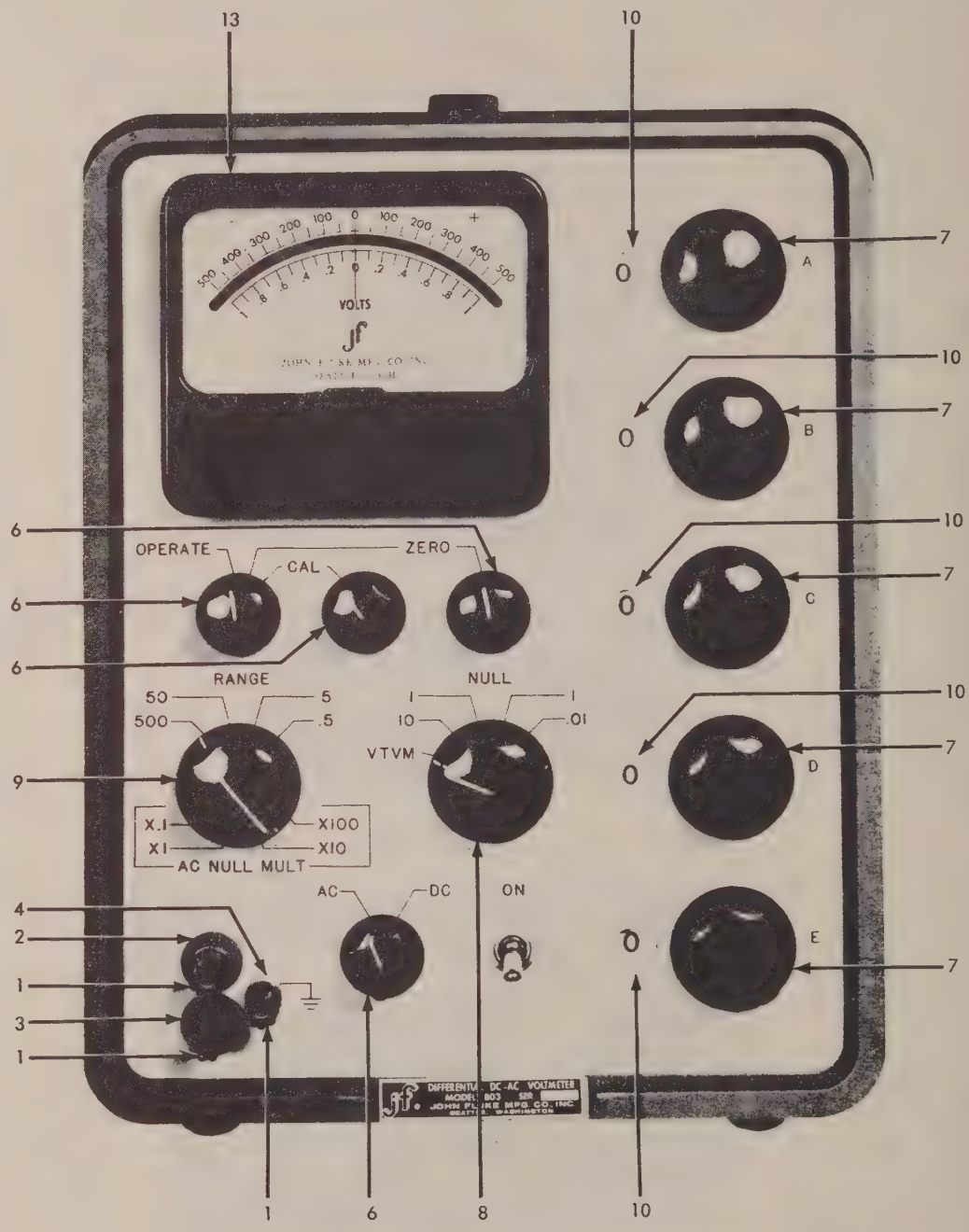


Figure 2-2. Front Panel Assembly (Sheet 1 of 2)

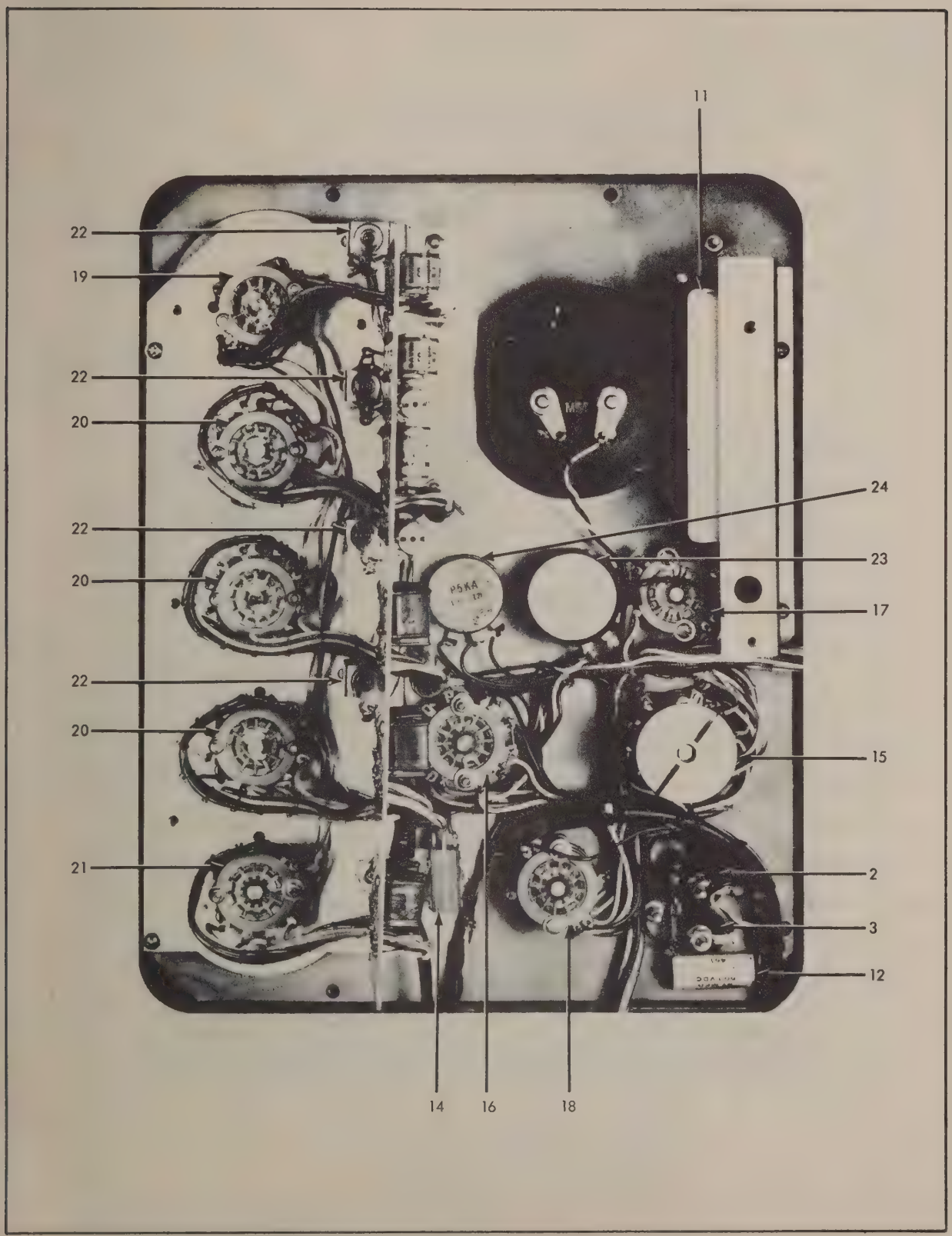


Figure 2-2. Front Panel Assembly (Sheet 2 of 2)

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-3-	803B-401	REFERENCE SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY (see figure 2-1-2 for next higher assembly)	Ref	
-1	EYS-20-500	. CAPACITOR, electrolytic, 20 uf -10/+100%, 15V (82376)(CE52)	2	C101, C102
-2	D29220	. CAPACITOR, electrolytic, 4000 uf -10/+100%, 15V (56289)(CE23)	1	C103
-3	67P10404	. CAPACITOR, paper, 0.1 uf ±20%, 400V (56289)(CP4)	1	C104
-4	9FM647	. CAPACITOR, plastic, 0.033 uf ±20%, 600V (72354)(CF19)	1	C105
-5	9FM665M	. CAPACITOR, plastic, 0.1 uf ±20%, 600V (72354)(CF20)	1	C106
-6	IN547	. DIODE, silicon, 750 ma, 600 PIV (03877)(RE18)	4	CR101, CR102, CR103, CR106
-7	TM1	. DIODE, silicon, 1 amp, 50 PIV (03877)(RE8) .	2	CR104, CR105
-8	2N214	. TRANSISTOR, germanium, NPN, 2N214 (93332)	1	Q1
-9	2N1372	. TRANSISTOR, germanium, PNP, 2N1372 (01295)	1	Q2
-10	EB1051	. RESISTOR, composition, 1 Meg ±10%, 1/2W (04061)	1	R101
-11	EB2241	. RESISTOR, composition, 220K ±10%, 1/2W (04061)	2	R102, R118
-12	EB27G1	. RESISTOR, composition, 2.7Ω ±10%, 1/2W (04061)	1	R103
-13	Type C12	. RESISTOR, deposited carbon, 5K ±1%, 1/2W (00327)(DR49)	1	R104
-14	Type C12	. RESISTOR, deposited carbon, 135K ±1%, 1/2W (00327)(DR65)	1	R105
-15	EB1831	. RESISTOR, composition, 18K ±10%, 1/2W (04061)	1	R106
-16	Type C12	. RESISTOR, deposited carbon, 50Ω ±1%, 1/2W (00327)(DR22)	2	R107, R108
-17	GB2741	. RESISTOR, composition, 270K ±10%, 1W (04061)	2	R109, R110
-18	EB2261	. RESISTOR, composition, 22 Meg ±10%, 1/2W (04061)	1	R111
-19	EB1561	. RESISTOR, composition, 15 Meg ±10%, 1/2W (04061)	1	R112
-20	EB1061	. RESISTOR, composition, 10 Meg ±10%, 1/2W (04061)	1	R113
-21	GB1041	. RESISTOR, composition, 100K ±10%, 1W (04061)	1	R114
-22	Type 1700S	. RESISTOR, wirewound, 140K ±3%, 10W (00213)(R140KW)	1	R115
-23	EB1041	. RESISTOR, composition, 100K ±10%, 1/2W (04061)	1	R116
-24	GB5641	. RESISTOR, composition, 560K ±10%, 1W (04061)	2	R117, R122
-25	EB3311	. RESISTOR, composition, 330Ω ±10%, 1/2W (04061)	1	R119
-26	GB2241	. RESISTOR, composition, 220K ±10%, 1W (04061)	1	R120
-27	Type 110	. RESISTOR, variable, wirewound, 5K ±20%, 1-1/4W (71450)(P5KM).	1	R121
-28	Type 1252	. RESISTOR, wirewound, 386K ±0.5%, 1/2W (15909)(PR641)	1	R123

FIG. & INDEX NO.	PART NO.	DESCRIPTION	QTY. PER ASSY.	REFERENCE DESIGNATION
2-3-29	Type 1112	. RESISTOR, wirewound, 76K ±0.5%, 1/2W (15909)(PR59)	1	R124
-30	EB8231	. RESISTOR, composition, 82K ±10%, 1/2W (04061)	1	R125
-31	EL84/6BQ5*	. ELECTRON TUBE, EL84/6BQ5 (73445)	1	V101
-32	OG3*	. ELECTRON TUBE, OG3 (73445)	1	V102
-33	NE2E	. LAMP, neon glow, NE2E (89730)(X40B)	1	V103
-34	12AX7*	. ELECTRON TUBE, 12AX7 (73445)	2	V104, V105

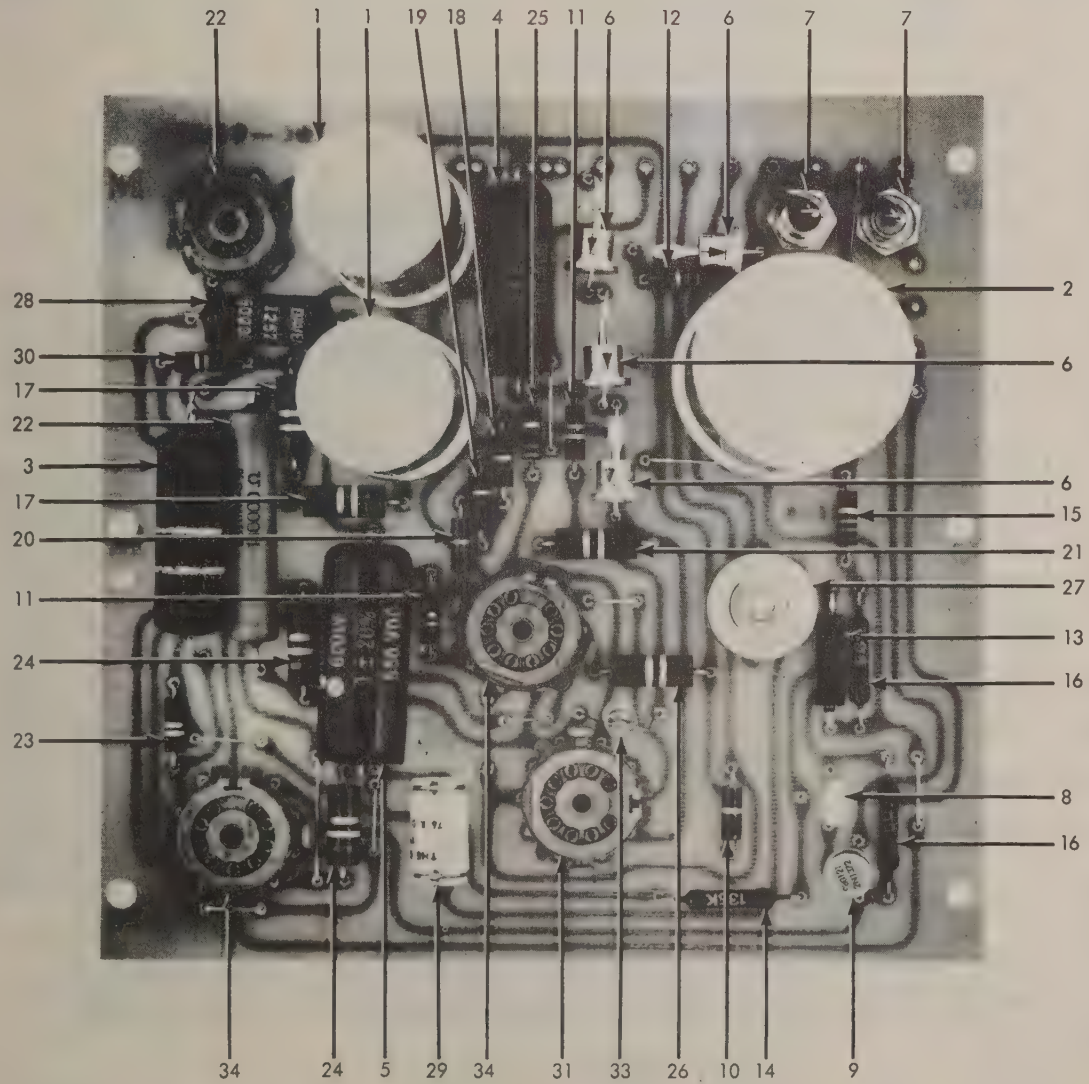


Figure 2-3. Reference Supply PCB Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-4-	803B-402	NULL DETECTOR PRINTED CIRCUIT BOARD ASSEMBLY (see figure 2-1-3 for next higher assembly)	Ref	
-1	600ue10402W	. CAPACITOR, plastic, 0.1 uf ±20%, 200V (84411)(CF46)	4	C201, C202 C208, C210
-2	600ue473-0-1	. CAPACITOR, plastic, 0.047 uf ±20%, 200V (84411)(CF47)	1	C203
-3	600ue47402	. CAPACITOR, plastic, 0.47 uf ±20%, 200V (84411)(CF48)	2	C204, C209
-4	TE-1095	. CAPACITOR, electrolytic, 40 uf -10/+100%, 6V (56289)(CE32)	1	C205
-5	30GA-D10	. CAPACITOR, ceramic, 0.001 uf ±20%, 3000V (56289)(CT16)	1	C206
-6	TE-1507	. CAPACITOR, electrolytic, 10 uf -10/+100%, 150V (56289)(CE67)	1	C207
-7	X663UW-10502(2)	. CAPACITOR, plastic, 1 uf ±20%, 200V (84411) (CF50)	1	C211
-8	30D137A1	. CAPACITOR, electrolytic, 200 uf -10/+100%, 6V (56289)(CE30)	1	C212
-9	DD-3R3	. CAPACITOR, ceramic, 3.3 uf +15%, 1000V (71590)(CT10)	1	C213
-10	EZ(PCB)-20/20-450V	. CAPACITOR, dual electrolytic, 20/20 uf -10/+50%, 450V (82376)(CE72)	1	C214A, C214B
-11	IN547	. DIODE, silicon, 0.75 amp, 600 PIV (03877) (RE18)	1	CR201
-12	C-2701*	. CHOPPER, electronic, 60 cycle, SPDT (98743) (X2045)	1	G1
-13	EB1051	. RESISTOR, composition, 1 Meg ±10%, 1/2W (04061)	6	R201, R202, R203, R209, R210, R214
-14	EB3951	. RESISTOR, composition, 3.9 Meg ±10%, 1/2W (04061)	1	R204
-15	EB2751	. RESISTOR, composition, 2.7 Meg ±10%, 1/2W (04061)	1	R205
-16	EB4741	. RESISTOR, composition, 470K ±10%, 1/2W (04061)	1	R206
-17	EB4721	. RESISTOR, composition, 4.7K ±10%, 1/2W (04061)	1	R207
-18	EB1031	. RESISTOR, composition, 10K ±10%, 1/2W (04061)	1	R208
-19	EB1841	. RESISTOR, composition, 180K ±10%, 1/2W (04061)	1	R212
-20	EB1021	. RESISTOR, composition, 1K ±10%, 1/2W (04061)	4	R213, R225, R226, R230
-21	EB2731	. RESISTOR, composition, 27K ±10%, 1/2W (04061)	1	R215
-22	EB5611	. RESISTOR, composition, 560Ω ±10%, 1/2W (04061)	1	R216
-23	EB1011	. RESISTOR, composition, 100Ω ±10%, 1/2W (04061)	1	R217
-24	Type C12	. RESISTOR, deposited carbon, 93.1Ω ±1%, 1/2W (00327)(DR822)	1	R218
-25	Type 110	. RESISTOR, variable, wirewound, 10Ω ±20%, 1-1/4W (71450)(P10)	1	R219
-26	EB3321	. RESISTOR, composition, 3.3K ±10%, 1/2W (04061)	2	R220, R221

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-4-27	HB4731	. RESISTOR, composition, 47K ±10%, 2W (04061)	2	R222, R223
-28	EB27G1	. RESISTOR, composition, 2.7Ω ±10%, 1/2W (04061)	1	R224
-29	HB2721	. RESISTOR, composition, 2.7K ±10%, 2W (04061)	2	R228, R229
-30	EB3341	. RESISTOR, composition, 330K ±10%, 1/2W (04061)	1	R231
-31	NE2X	. LAMP, neon glow, NE2X (89730)(X40A)	1	V201
-32	EF86/6267*	. ELECTRON TUBE, EF86/6267 (73445)	1	V202
-33	6AW8*	. ELECTRON TUBE, 6AW8 (49671)	1	V203
-34	OA2*	. ELECTRON TUBE, OA2 (49671)	1	V204

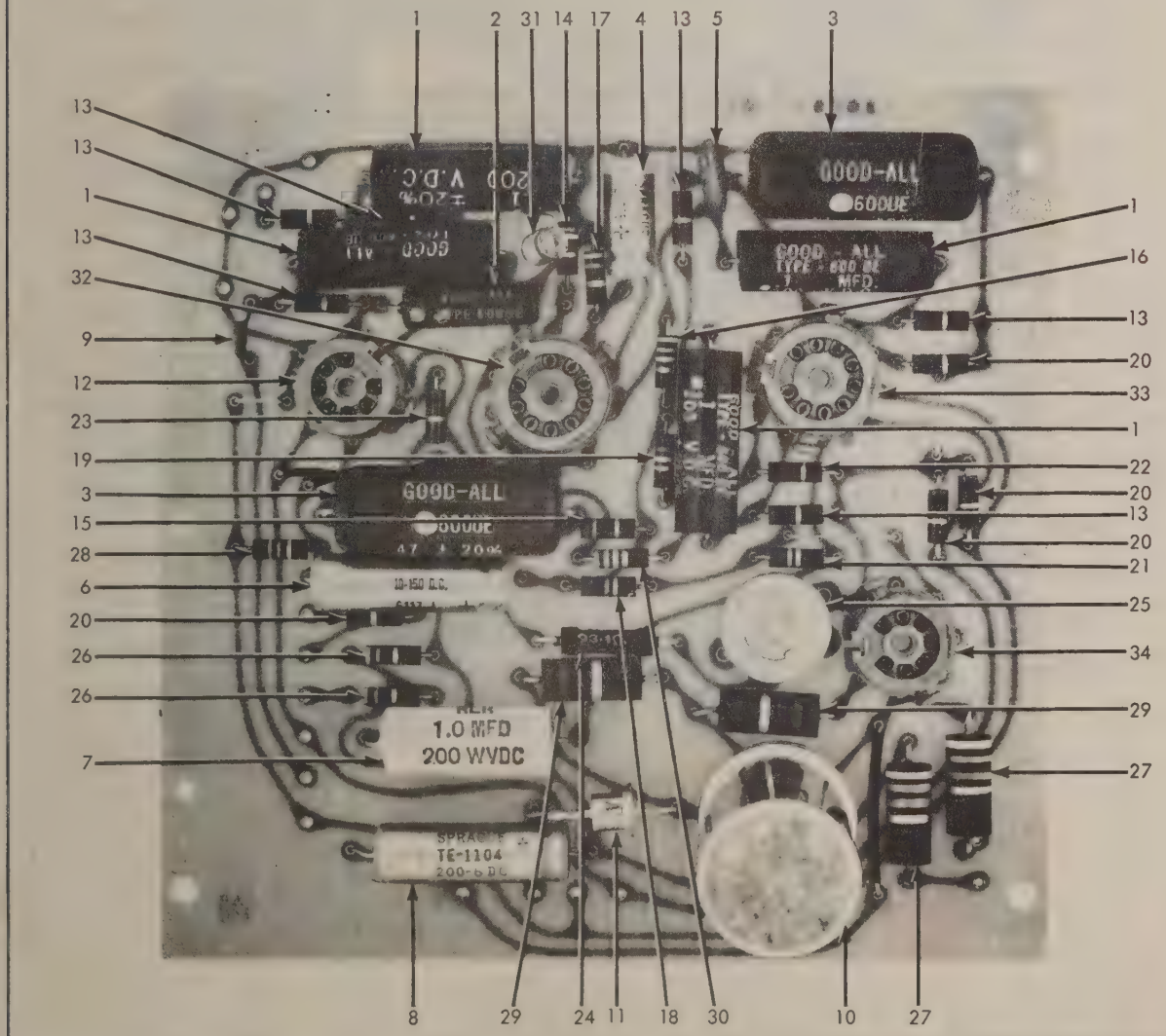


Figure 2-4. Null Detector PCB Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-5-	803B-403	RANGE RESISTOR PRINTED CIRCUIT BOARD ASSEMBLY (see figure 2-1-4 for next higher assembly)	Ref	
-1	E6-105	. CAPACITOR, plastic, 1 uf ±20%, 600V (99515)(CP33)	1	C301
-2	X663UW 20502(2)	. CAPACITOR, plastic, 2 uf ±20%, 200V (84411)(CF51)	1	C302
-3	Type C13	. RESISTOR, deposited carbon, 10 Meg ±1%, 1W (00327)(DR80)	4	R301 thru R304
-4	Type C13	. RESISTOR, deposited carbon, 9 Meg ±1%, 1W (00327)(DR78)	1	R305
-5	Type C12	. RESISTOR, deposited carbon, 900K ±1%, 1/2W (00327)(DR622)	1	R306
-6	Type C12	. RESISTOR, deposited carbon, 90K ±1%, 1/2W (00327)(DR513)	1	R307
-7	Type C12	. RESISTOR, deposited carbon, 9K ±1%, 1/2W (00327)(DR412)	1	R308
-8	Type C12	. RESISTOR, deposited carbon, 1K ±1%, 1/2W (00327)(DR41)	1	R309
-9	Type 1180F	. RESISTOR, wirewound, 125K ±0.1%, 1W (15909)(PR610)	2	R316, R317
-10	Type 110	. RESISTOR, variable, wirewound, 1K ±20%, 1-1/4W (71450)(P1KM)	1	R318
-11	Type 1112	. RESISTOR, wirewound, 511.7Ω ±0.1%, 1/2W (15909)(PR643)	1	R319
-12	Type 1181F	. RESISTOR, wirewound, 112.375K ±0.05%, 1W (15909)(PR615)	2	R320, R321
-13	GB2731	. RESISTOR, composition, 27K ±10%, 1W (04061)	1	R322
-14	Type 110	. RESISTOR, variable, wirewound, 500 ±10%, 1-1/4W (71450)(P500M)	3	R323, R326, R329
-15	Type 1141	. RESISTOR, wirewound, 28.571K ±0.05%, 1/2W (15909)(PR515)	1	R324
-16	Type 1141	. RESISTOR, wirewound, 22.5K ±0.1%, 1/2W (15909)(PR513)	1	R325
-17	Type 1141	. RESISTOR, wirewound, 2531.7Ω ±0.05%, 1/2W (15909)(PR49)	1	R327
-18	Type 1141	. RESISTOR, wirewound, 24.75K ±0.1%, 1/2W (15909)(PR514)	1	R328
-19	Type 1141	. RESISTOR, wirewound, 250.31Ω ±0.05%, 1/2W (15909)(PR311)	1	R330
-20	EB2711	. RESISTOR, composition, 270Ω ±10%, 1/2W (04061)	1	R331

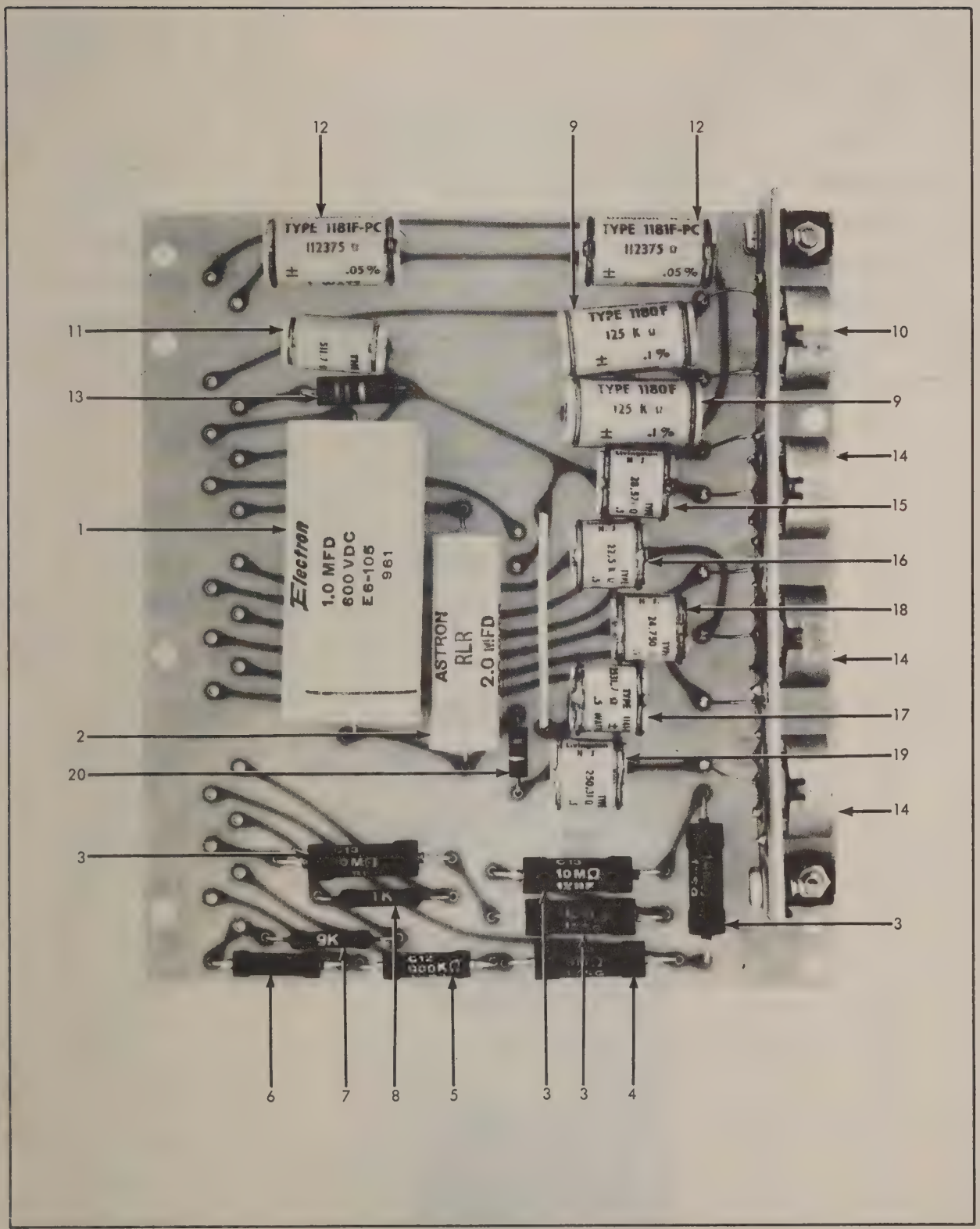


Figure 2-5. Range Resistor PCB Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-6-	801B-403	KELVIN-VARLEY RESISTOR PCB ASSEMBLY (see figure 2-1-5 for next higher assembly). . . .	Ref	
-1	PR512**	. RESISTOR, wirewound, 40K ±0.02%, 1/2W (89536)	6	R401 thru R406
-2	PR48**	. RESISTOR, wirewound, 8K ±0.02%, 1/2W (89536)	11	R407 thru R417
-3	PR46**	. RESISTOR, wirewound, 1.6K ±0.1%, 1/2W (89536)	11	R418 thru R428
-4	PR39	. RESISTOR, wirewound, 320Ω ±0.1%, 1/2W (89536)	11	R429 thru R439
-5	PR24	. RESISTOR, wirewound, 64Ω ±0.1%, 1/2W (89536)	11	R440 thru R449

**These resistors are factory matched for each instrument. When ordering, specify instrument serial number.

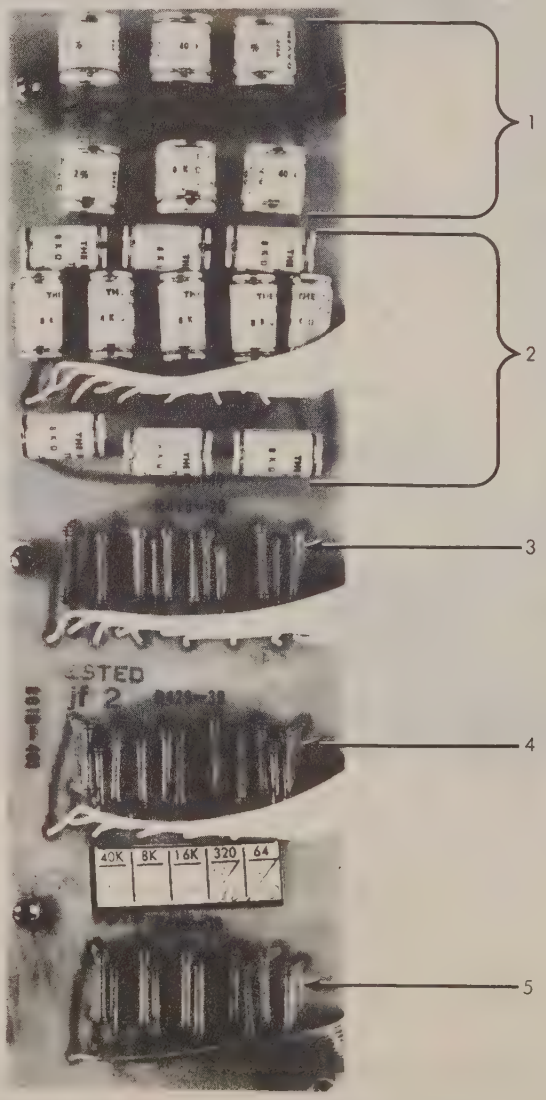


Figure 2-6. Kelvin-Varley Resistor PCB Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-7-	803B-434	CONVERTER/AC RANGE SWITCH ASSEMBLY (see figure 2-1-6 for next higher assembly). . . .	Ref	
-1	803B-405	. CONVERTER ASSEMBLY (89536)	1	
-2	D29221	. . CAPACITOR, dual electrolytic, 10/10 uf -10/+50%, 500V (56289)(CE20)	1	C505A, C505B
-3	DD502	. . CAPACITOR, ceramic, 0.005 uf ±20%, 500V (04061)(CT17)	1	C506
-4	BB60301KW7W	. . CAPACITOR, ceramic, 300 uuf ±10%, 500V (71590)(CT28)	1	C507
-5	600UE47402	. . CAPACITOR, plastic, 0.47 uf ±20%, 200V (84411)(CF48)	2	C508, C511
-6	Type 600UE	. . CAPACITOR, plastic, 0.0068 uf ±20%, 400V (84411)(CF53)	1	C509
-7	30GA-D10	. . CAPACITOR, ceramic, 0.001 uf ±20%, 3000V (56289)(CT16)	1	C510
-8	67P10404	. . CAPACITOR, paper, 0.1 uf ±20%, 400V (56289)(CP4).	1	C512
-9	30D198A1	. . CAPACITOR, electrolytic, 20 uf -10/+100%, 50V (56289)(CE41)	1	C513
-10	UK225	. . CAPACITOR, ceramic, 2.2 uf -0%, 3V (71590)(CT45)	1	C514
-11	X663UW-20502	. . CAPACITOR, plastic, 2 uf ±20%, 200V (84411)(CF51)	2	C515, C518
-12	F233F105M	. . CAPACITOR, plastic, 1uf ±20%, 600V (72354)(CF54)	1	C516
-13	D2-505	. . CAPACITOR, plastic, 5 uf ±20%, 200V (99515)(CP36)	1	C517
-14	30D120A1	. . CAPACITOR, electrolytic, 500 uf -10/+100%, 3V (56289)(CE61)	1	C522
-15	S9G	. . DIODE, silicon, 60 ma, 40 PIV (03877) (RE7)	2	CR501, CR502
-16	Type C42S	. . RESISTOR, metal film, 68K ±5%, 2W (07115)(MR45).	2	C506, R507
-17	Type C42S	. . RESISTOR, metal film, 56K ±5%, 2W (07115)(MR44).	1	R508
-18	Type LP1-5	. . RESISTOR, metal film, 100K ±5%, 5W (07115)(MR43).	1	R509
-19	EB3321	. . RESISTOR, composition, 3.3K ±10%, 1/2W (04061)	2	R510, R511
-20	EB2211	. . RESISTOR, composition, 220Ω ±10%, 1/2W (04061)	2	R512, R531
-21	EB2711	. . RESISTOR, composition, 270Ω ±10%, 1/2W (04061)	1	R513
-22	EB1851	. . RESISTOR, composition, 1.8 Meg ±10%, 1/2W (04061)	2	R514, R518
-23	EB2251	. . RESISTOR, composition, 2.2 Meg ±10%, 1/2W (04061)	1	R515
-24	EB1561	. . RESISTOR, composition, 15 Meg ±10%, 1/2W (04061)	1	R516
-25	EB1861	. . RESISTOR, composition, 18 Meg ±10%, 1/2W (04061)	1	R517
-26	EB4701	. . RESISTOR, composition, 47Ω ±10%, 1/2W (04061)	2	R519, R527
-27	Type C42S	. . RESISTOR, metal film, 120K ±5%, 2W (07115)(MR46).	1	R520
-28	EB1811	. . RESISTOR, composition, 180Ω ±10%, 1/2W (04061)	1	R521
-29	EB1031	. . RESISTOR, composition, 10K ±10%, 1/2W (04061)	2	R522, R533

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-7-30	EB3911	. . RESISTOR, composition, 390Ω ±10%, 1/2W (04061)	1	R523
-31	EB3341	. . RESISTOR, composition, 330K ±10%, 1/2W (04061)	1	R524
-32	EB4741	. . RESISTOR, composition, 470K ±10%, 1/2W (04061)	2	R525, R532
-33	EB2241	. . RESISTOR, composition, 220K ±10%, 1/2W (04061)	1	R526
-34	Type C42S	. . RESISTOR, metal film, 150K ±5%, 2W (07115)(MR47)	1	R528
-35	GB1041	. . RESISTOR, composition, 100K ±10%, 1W (04061)	1	R529
-36	Type LP1-5	. . RESISTOR, metal film, 47K ±5%, 5W (07115)(MR42)	1	R530
-37	EB3351	. . RESISTOR, composition, 3.3 Meg ±10%, 1/2W (04061)	1	R534
-38	Type 110	. . RESISTOR, variable, wirewound, 5K ±5%, 1-1/4W (71450)(P5KM)	1	R535
-39	Type 110	. . RESISTOR, variable, wirewound, 1K ±20%, 1-1/4W (71450)(P1KM)	1	R536
-40	Type C12	. . RESISTOR, deposited carbon, 100K ±1%, 1/2W (00327)(DR61)	1	R537
-41	Type 1141	. . RESISTOR, wirewound, 21.4K ±0.1%, 1/2W (15909)(PR659)	1	R538
-42	Type R1136	. . RESISTOR, wirewound, 490Ω ±0.1%, 1/2W (15909)(PRA18)	1	R539
-43	EB2231	. . RESISTOR, composition, 22K ±10%, 1/2W (04061)	1	R543
-44	6EJ7*	. . ELECTRON TUBE, 6EJ7 (73445)	1	V501
-45	6AW8*	. . ELECTRON TUBE, 6AW8 (49671)	1	V502
-46	803B-428-1	. AC RANGE SWITCH GAIN ADJUST ASSEMBLY (89536)	1	
-47	Type 110	. . RESISTOR, variable, wirewound, 300Ω ±10%, 1-1/4W (71450)(P300B)	1	R503
-48	Type 110	. . RESISTOR, variable, wirewound, 1.5K ±20%, 1-1/4W (71450)(P1.5KM)	1	R541
-49	803B-428-2	. AC RANGE SWITCH ATTENUATOR ASSEMBLY (89536)	1	
-50	VCJ1014	. . CAPACITOR, variable, air, 0.8 to 4.5 uuf, 500V (73899)(CA4)	1	C501
-51	TU45301KCOG	. . CAPACITOR, ceramic, 300 uuf ±5%, 600V (71590)(CT13)	1	C502
-52	D6-474	. . CAPACITOR, plastic, 0.47 uf ±20%, 600V (99515)(CP25)	1	C503
-53	Type 1307	. . RESISTOR, wirewound, 1 Meg ±0.1%, 1/2W (15909)(PRA19)	1	R501
-54	Type 1137	. . RESISTOR, wirewound, 10.05K ±0.1%, 1/2W (15909)(PRA21)	1	R502
-55	803B-428-3	. AC RANGE SWITCH GAIN NETWORK ASSEMBLY (89536)	1	
-56	VCJ1014	. . CAPACITOR, variable, air, 0.8 to 4.5 uuf 500V (73899)(CA4)	2	C504, C519
-57	TCZ-3R3	. . CAPACITOR, ceramic, 3.3 uuf ±20%, 600V (71590)(CT55)	1	C520
-58	TCZ-82	. . CAPACITOR, ceramic, 82 uuf ±2%, 600V (71590)(CT36)	1	C521
-59	Type DA2	. . RESISTOR, metal film, 1 Meg ±1%, 1/2W (15909)(MR48)	1	R504
-60	EB4701	. . RESISTOR, composition, 47Ω ±10%, 1/2W (04061)	1	R505

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
2-7-61	Type DA2	. . RESISTOR, metal film, 500K ±1%, 1/2W (15909)(MR50)	1	R540
-62	Type DA2	. . RESISTOR, metal film 48.5K ±1%, 1/2W (15909)(MR49).	1	R542
-63	803B-428-4	. AC RANGE SWITCH ASSEMBLY (89536). . . .	1	
-64	803B-813	. . SWITCH, range, AC section (89536) . .	1	S2

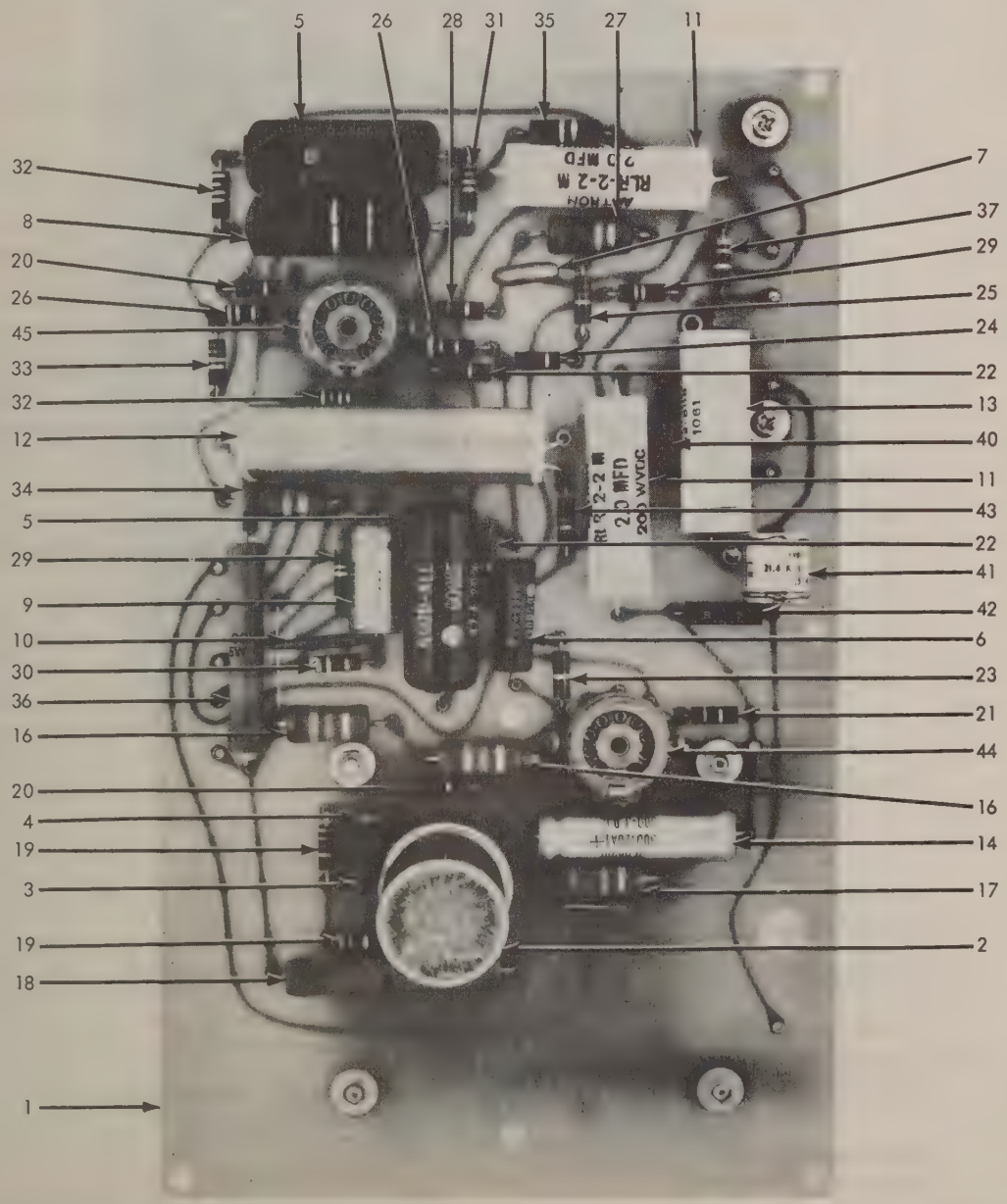


Figure 2-7. Converter/AC Range Switch Assembly (Sheet 1 of 2)

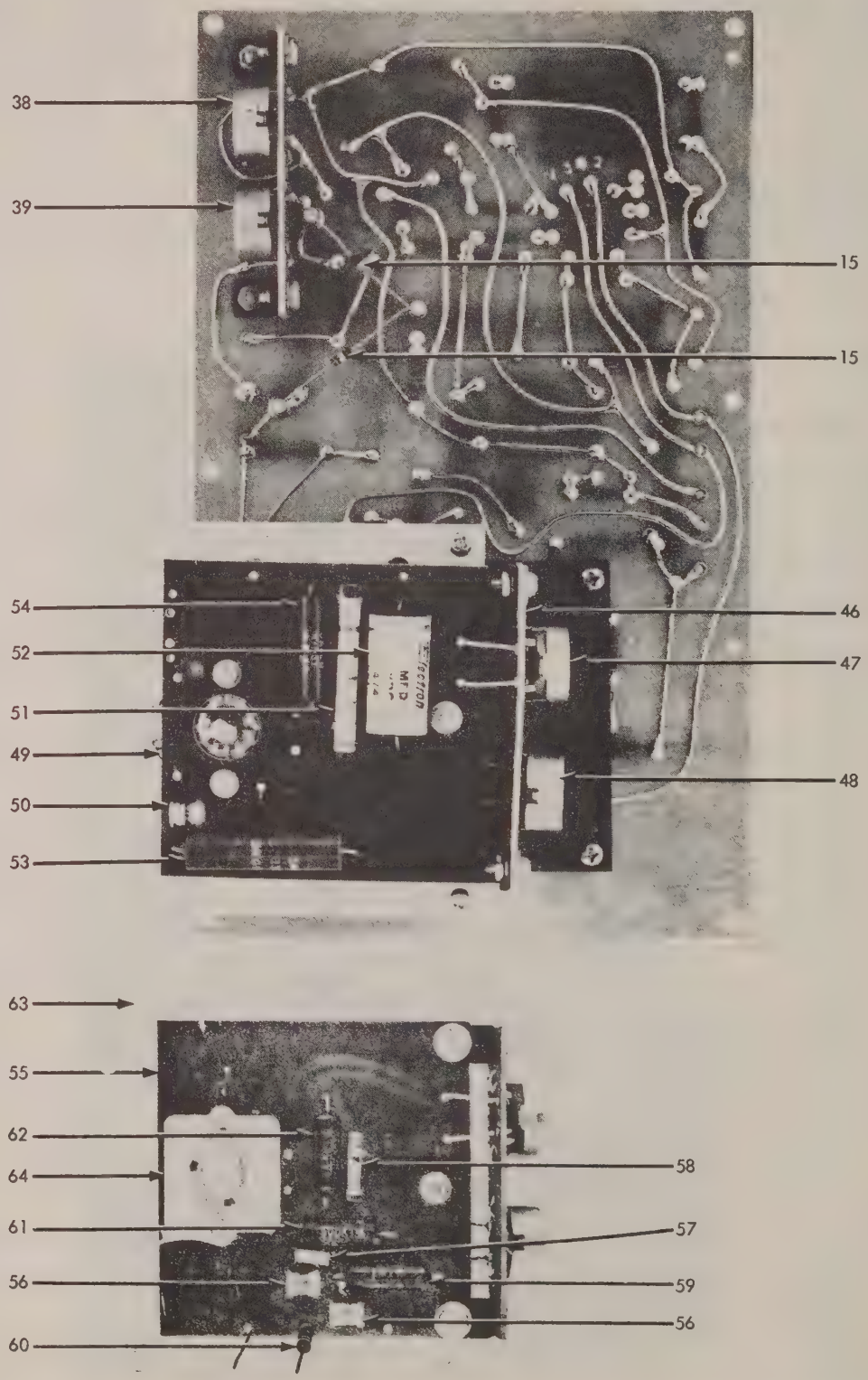


Figure 2-7. Converter/AC Range Switch Assembly (Sheet 2 of 2)

SECTION III

PARTS BREAKDOWN MODEL 803B

3-1. INTRODUCTION

a. This parts breakdown provides positive identification of parts necessary for support of the Model 803B AC/DC Differential Voltmeter. Sufficient information necessary to order any needed replacements is also included.

b. Seven figures in this section illustrate the final assembly of the 803B and various assemblies and sub-assemblies. Each figure is accompanied by a corresponding parts list, the tabular columns of which are Figure and Index Number, Part Number, Description, Quantity Per Assembly, and Reference Designation.

c. The first entry in the Figure and Index Number column of each parts list is a figure number only, with no reference number. This figure number refers to the corresponding illustration. Succeeding dash numbers are reference numbers on the corresponding illustration with leader lines and arrows to the specific parts.

d. Entries in the Part Number column are part numbers assigned by the company that controls the design of the part. Parts not illustrated are designated by an asterisk following the part number.

e. The Description column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and attached parts relationship. The manufacturer's code number of the company that controls the design of the part follows the nomenclature of the part. The manufacturer's code numbers are from the Federal Cataloging Handbook, H4-1. The John Fluke Part number assigned to vendor parts follows the manufacturer's code number.

f. The number in the Quantity Per Assembly column indicates the total quantity of the part used on the assembly below which the part is listed. "Ref" indicates that the assembly is listed under the next higher assembly and is cross-referenced by figure and index number in the Description column. The quantity per assembly is given in the referenced figure.

g. Entries in the Reference Designation column indicate the reference designations used on the schematic diagram.

3-2. FEDERAL SUPPLY CODE FOR MANUFACTURERS

Code	Manufacturer
00213	Sage Electronics Corp. Rochester, New York
00327	Welwyn International, Inc. Cleveland, Ohio
03614	Bussmann Fuse Div. of Mc Graw-Edison Co. Los Angeles, Calif.
03877	Transitron Electronic Corp. Wakefield, Mass.
03980	Muirhead Instruments, Inc. New York, New York
04009	Arrow Hart and Hegeman Electric Company Hartford, Conn.
04061	Allen-Bradley Co. Chicago, Ill.
04645	Kurz-Kasch, Inc. Chicago, Illinois
07115	Corning Glass Works Electronic Components Dept. Bradford, Pa.
09213	Semi-Conductor Products Dept. General Electric Co. Buffalo, New York
12697	Clarostat Mfg. Co., Inc. Dover, New Hampshire
14099	Semtech Corp. Newbury Park, California

Code	Manufacturer
15909	Daven Company Livingston, New Jersey
24655	General Radio Co. West Concord, Mass.
49671	Radio Corp. of America New York, New York
56289	Sprague Electric Co. North Adams, Mass.
63743	Ward Leonard Electric Co. Mount Vernon, New York
71450	CTS Corp. Elkart, Indiana
71590	Centralab Div. of Globe Union, Inc. Milwaukee, Wisconsin
73445	Amperex Electronic Co. Div. of North American Philips Co., Inc. Hicksville, New York
73899	JFD Electronics Corp. Brooklyn, New York
81483	Industrial Rectifier Corp. El Segundo, Calif.
82376	Astron Company East Newark, N. J.
84411	Good-All Electric Mfg. Co. Ogallala, Nebraska
89536	Fluke, John, Mfg. Co., Inc. Seattle, Washington
89730	General Electric Co. Newark Lamp Works of Lamp Div. of Consumer Products Group Newark, New Jersey
89743	Mattern Corporation Chicago, Illinois
95263	Leecraft Manufacturing Co. Inc. New York, New York
98388	Accurate Sales Co., Inc. Culver City, Calif.
95515	Marshal Industries, Electron Prod. Div. Pasadena, Calif.

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-1-	803B	MODEL 803B AC/DC DIFFERENTIAL VOLTMETER Final Assembly (89536)	Ref.	
-1	138586	. FRONT PANEL ASSEMBLY (see figure 3-2) (89536)	1	
-2	125088	. REFERENCE SUPPLY BOARD ASSEMBLY (see figure 3-3) (89536)	1	
-3	150029	. NULL DETECTOR BOARD ASSEMBLY (see figure 3-4) (89536)	1	
-4	159541	. RANGE RESISTOR BOARD ASSEMBLY (see figure 3-5) (89536)	1	
-5	134775	. KELVIN-VARLEY RESISTOR BOARD ASSEMBLY (see figure 3-6) (89536)	1	
-6	120527	. CONVERTER/AC RANGE SWITCH ASSEMBLY (see figure 3-7) (89536)	1	
-7	MDL-1.5	. FUSE, 1.5 ampere, slow-blowing (03614) (109231)	1	F1
-8	938-D	. BINDING POST (24655) (104158)	2	J4, J5
-9	135053	. INSULATOR, binding post, black (89536)	2	
-10	116707	. TRANSISTOR, germanium, PNP, special purpose (89536)	1	Q3
-11	CM11406	. RESISTOR, variable, wirewound, 5K ±10%, 2W (12697) (11583)	1	R1
-12	5F-6000*	. RESISTOR, wirewound, 6K ± 5%, 5W (63743) (113449)	2	R6, R7
-13	149088	. TRANSFORMER, power (89536)	1	T1
-14	102822	. CABLE, power, 3 wire (89536)	1	
-15	120386*	. CASE ASSEMBLY (89536)	1	
-16	BH2097*	. . FOOT, rubber (98388) (101253)	4	
-17	407-101*	. . HANDLE, flexible black vinyl, 5-1/2 inch (89536)	1	

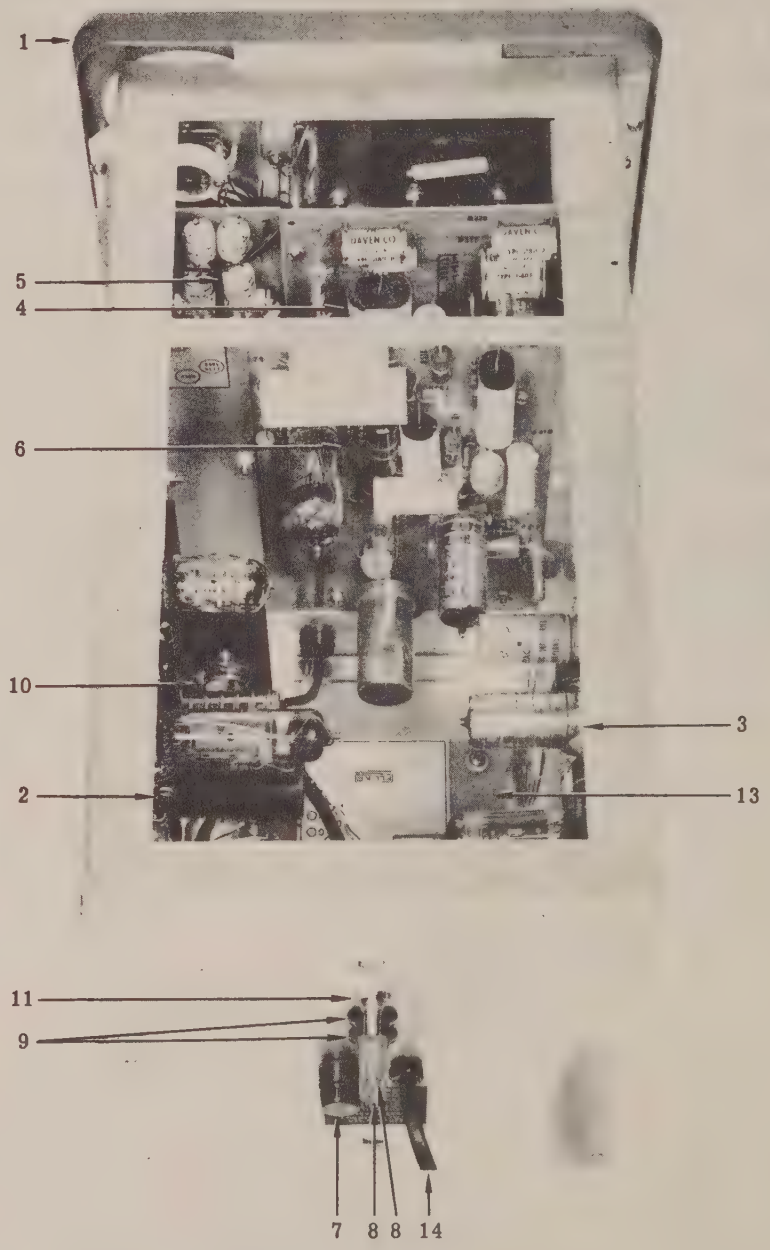


Figure 3-1. Final Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-2-	138586	FRONT PANEL ASSEMBLY (see figure 3-1-1 for next higher assembly)	Ref.	
-1	D-845C	. STANDARD CELL (03980) (135160)	1	B1
-2	D6-474	. CAPACITOR, mylar, 0.47 uf ±10%, 600V (99515) (105494)	1	C1
-3	7-14	. INDICATOR LAMP HOLDER (95263) (100131)	4	
-4	Type 47*	. LAMP, incandescent (89730) (102855)	4	DS1, DS2, DS3, DS4
-5	101428*	. SHIELD, lamp (89536)	4	
-6	938-D	. BINDING POST, red (24655) (104158)	2	J1, J3
-7	135053	. INSULATOR, binding post, dual (89536)	1	
-8	135061	. INSULATOR, binding post, black (89536)	2	
-9	938-C	. BINDING POST (24655) (101204)	1	J2
-10	938-F	. SPACER, binding post (89536)	1	
-11	938-L	. SHORTING LINK (24655) (101220)	1	
-12	S-653-3L-BB	. KNOB, 1-1/2 inch, with index line (04645) (103614)	1	
-13	S-647-3L	. KNOB, 1 inch, with pointer (04645) (101287)	3	
-14	S-642-3-BB	. KNOB, 1-1/2 inch, without pointer (04645) (101121)	5	
-15	X-653-3-BB-L	. KNOB, 1-1/2 inch, with pointer (04645) (101311)	1	
-16	107029	. DIAL PLATE, voltage (89536)	5	
-17	103440	. LENS, light (89536)	4	
-18	111211	. METER, 100-0-100 micro amp (89536)	1	M1
-19	2-252	. RESISTOR, variable, dual section wirewound, 1K and 100Ω ±10%, 2W (71450) (112714)	1	R2
-20	20994-LH	. SWITCH, power (04009) (114850)	1	S1
-21	120642	. SWITCH, range, dc section (89536)	1	S2
-22	120659	. SWITCH, null (89536)	1	S3
-23	134973	. SWITCH, operate-calibrate (89536)	1	S4
-24	120691	. SWITCH, ac-dc polarity (89536)	1	S5
-25	134817	. SWITCH, voltage dial A (89536)	1	S6
-26	134841	. SWITCH, voltage dial B, C, D (89536)	3	S7, S8, S9
-27	134825	. SWITCH, voltage dial E (89536)	1	S10

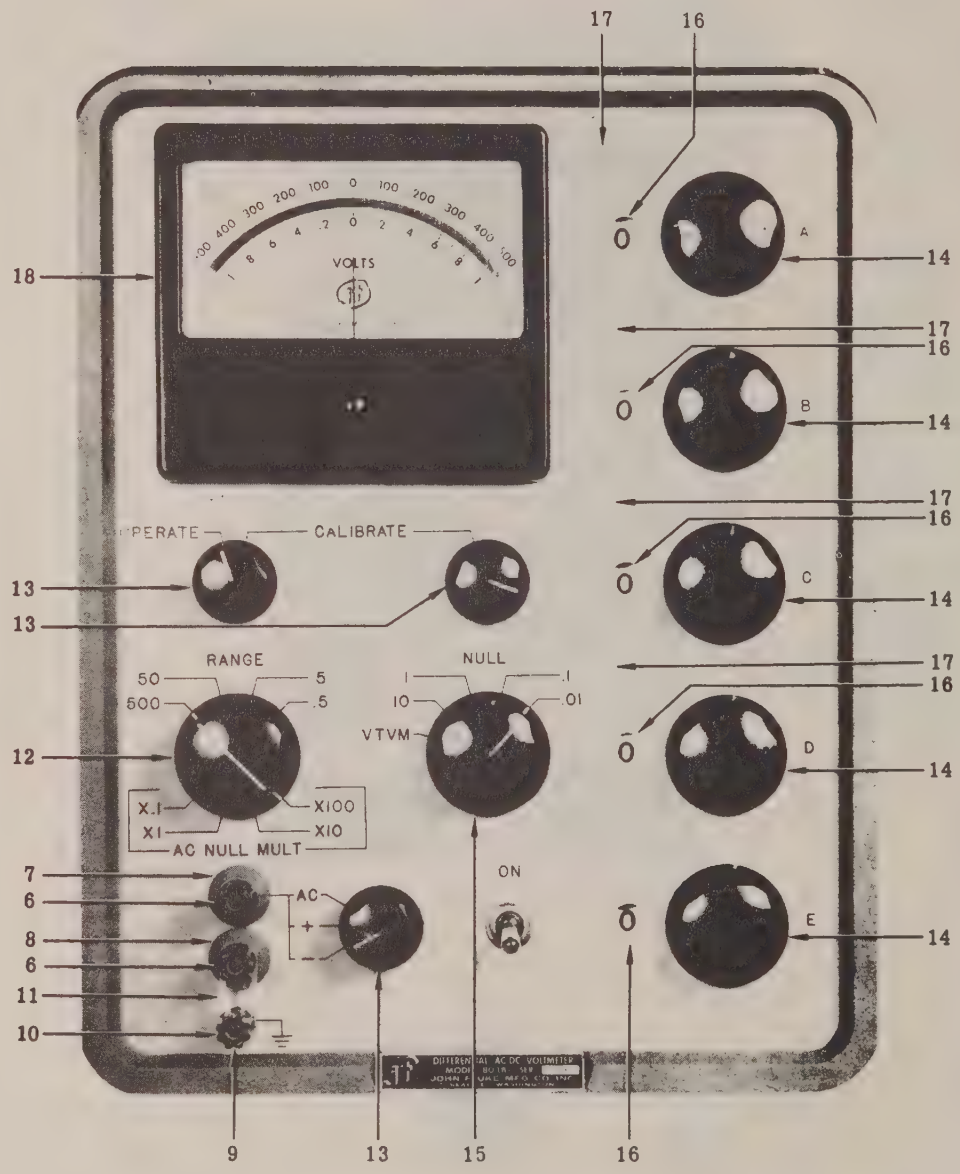


Figure 3-2. Front Panel Assembly (Sheet 1 of 2)

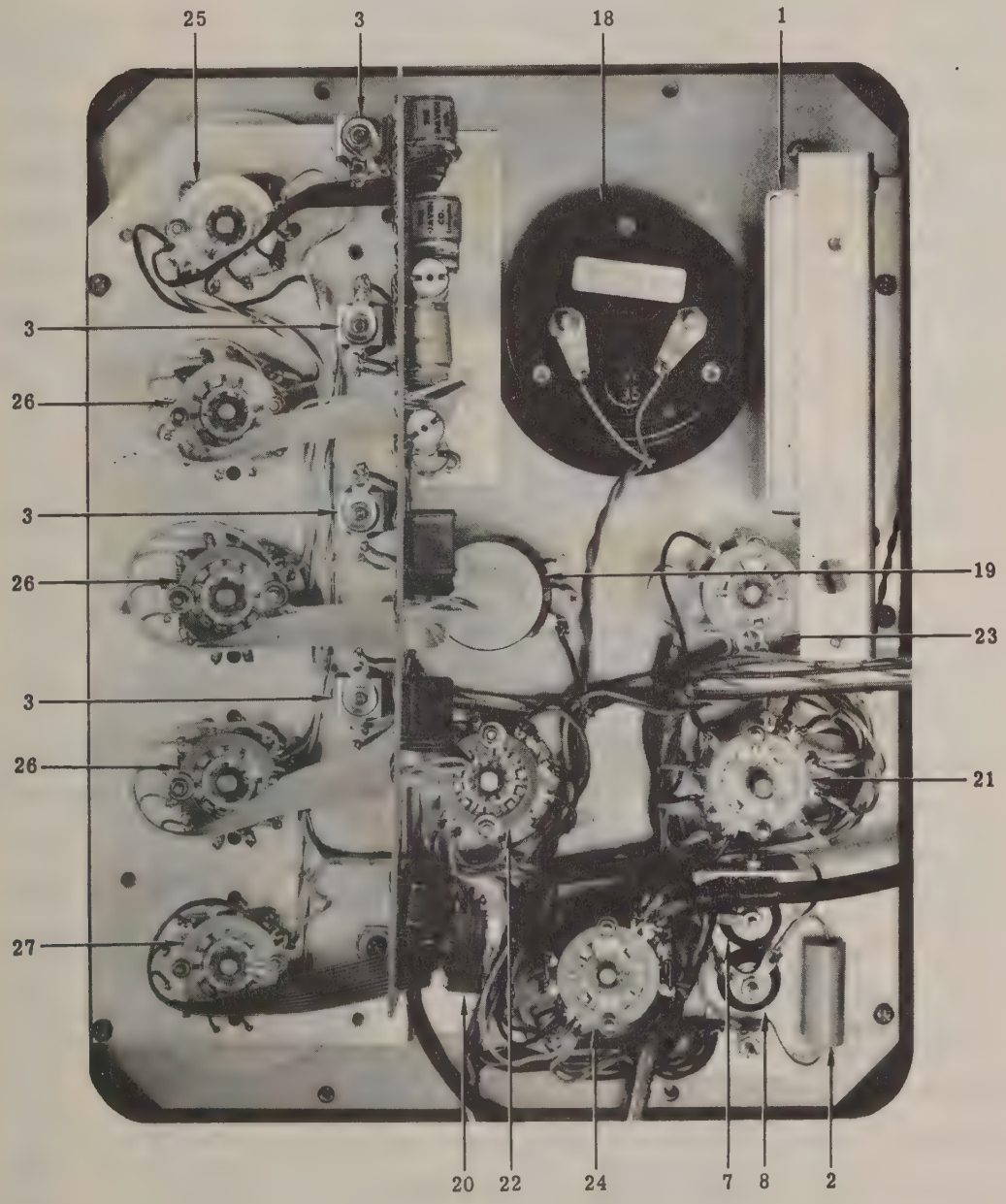


Figure 3-2. Front Panel Assembly (Sheet 2 of 2)

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-3-	120588	REFERENCE SUPPLY BOARD ASSEMBLY (see figure 3-1-2 for next higher assembly)	Ref.	
-1	EYS-20-500	. CAPACITOR, electrolytic 20 uf -10/+100%, 500V (82376) (105932)	2	C101, C102
-2	D29220	. CAPACITOR, electrolytic, 4000 uf -10/+100%, 15V (56289) (105163)	1	C103
-3	67P10404	. CAPACITOR, paper, 0.1 uf ±20%, 400V (56289) (105312)	1	C104
-4	600NE-333-06W	. CAPACITOR, plastic, 0.033 uf ±20%, 600V (84411) (105916)	1	C105
-5	600NE-104-06W	. CAPACITOR, plastic, 0.1 uf ±20%, 600V (84411) (105833)	1	C106
-6	29C9B5	. CAPACITOR, ceramic, 0.01 uf -20/+80%, 500V (56289) (105668)	1	C107
-7	SC6	. DIODE, silicon, 0.750 amp, 600 PIV (14099) (112383)	3	CR101, CR102, CR103
-8	TM1	. DIODE, silicon, lamp, 50 PIV (03877) (112409)	2	CR104, CR105
-9	2N2712	. TRANSISTOR, silicon, NPN, 2N2712 (09213) (117267)	1	Q1
-10	2N1372	. TRANSISTOR, germanium, PNP, 2N1372 (01295) (116129)	1	Q2
-11	EB1051	. RESISTOR, composition, 1 Meg ±10%, 1/2W (04061) (108134)	1	R101
-12	EB2241	. RESISTOR, composition, 220K ±10%, 1/2W (04061) (108217)	1	R102
-13	Type C12	. RESISTOR, carbon film, 5.44K ±1%, 1/2W (00327) (107235)	1	R104
-14	Type C12	. RESISTOR, carbon film, 125K ±1%, 1/2W (00327) (107433)	1	R105
-15	EB8221	. RESISTOR, composition, 8.2K ±10%, 1/2W (04061) (109017)	1	R106
-16	Type C12	. RESISTOR, carbon film, 50Ω ±1%, 1/2W (00327) (107037)	2	R107, R108
-17	GB2741	. RESISTOR, composition, 270K ±10%, 1W (04061) (109512)	2	R109, R110
-18	EB2261	. RESISTOR, composition, 22 Meg ±10%, 1/2W (04061) (108223)	1	R111
-19	EB1561	. RESISTOR, composition, 15 Meg ±10%, 1/2W (04061) (108647)	1	R112
-20	EB1061	. RESISTOR, composition, 10 Meg ±10%, 1/2W (04061) (108142)	1	R113
-21	GB1041	. RESISTOR, composition, 100K ±10%, 1W (04061) (109397)	1	R114
-22	Type 1700S	. RESISTOR, wirewound, 140K ±3%, 10W (00213) (112417)	1	R115
-23	EB1041	. RESISTOR, composition, 100K ±10%, 1/2W (04061) (108126)	1	R116
-24	EB5641	. RESISTOR, composition, 560K ±10%, 1W (04061) (109678)	1	R117
-25	EB2241	. RESISTOR, composition, 220K ±10%, 1/2W (04061) (108217)	1	R118
-26	EB3311	. RESISTOR, composition, 330Ω ±10%, 1/2W (04061) (108589)	1	R119
-27	GB2241	. RESISTOR, composition, 220K ±10%, 1W (04061) (109652)	1	R120
-28	Type 110	. RESISTOR, variable wirewound, 5K ±20%, 1-1/4W (71450) (111609)	1	R121

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-3-29	EB5641	. RESISTOR, composition, 560K ±10%, 1W (04061) (109678)	1	R122
-30	Type 1252	. RESISTOR, wirewound, 386K ±0.5%, 1W (15909) (112482)	1	R123
-31	Type 1112	. RESISTOR, wirewound, 76K ±0.5%, 1/2W (15909) (111948)	1	R124
-32	EB8231	. RESISTOR, composition, 82K ±10%, 1/2W (04061) (108498)	1	R125
-33	EL84/6BQ5	. ELECTRON TUBE, EL84/6BQ5 (73445) (116616)	1	V101
-34	116749	. ELECTRON TUBE, OG3-2 (89536)	1	V102
-35	NE2E	. LAMP, neon glow, NE2E, 1/10W (89730) (100347)	1	V103
-36	12AX7	. ELECTRON TUBE, 12AX7 (73445) (115956)	2	V104, V105

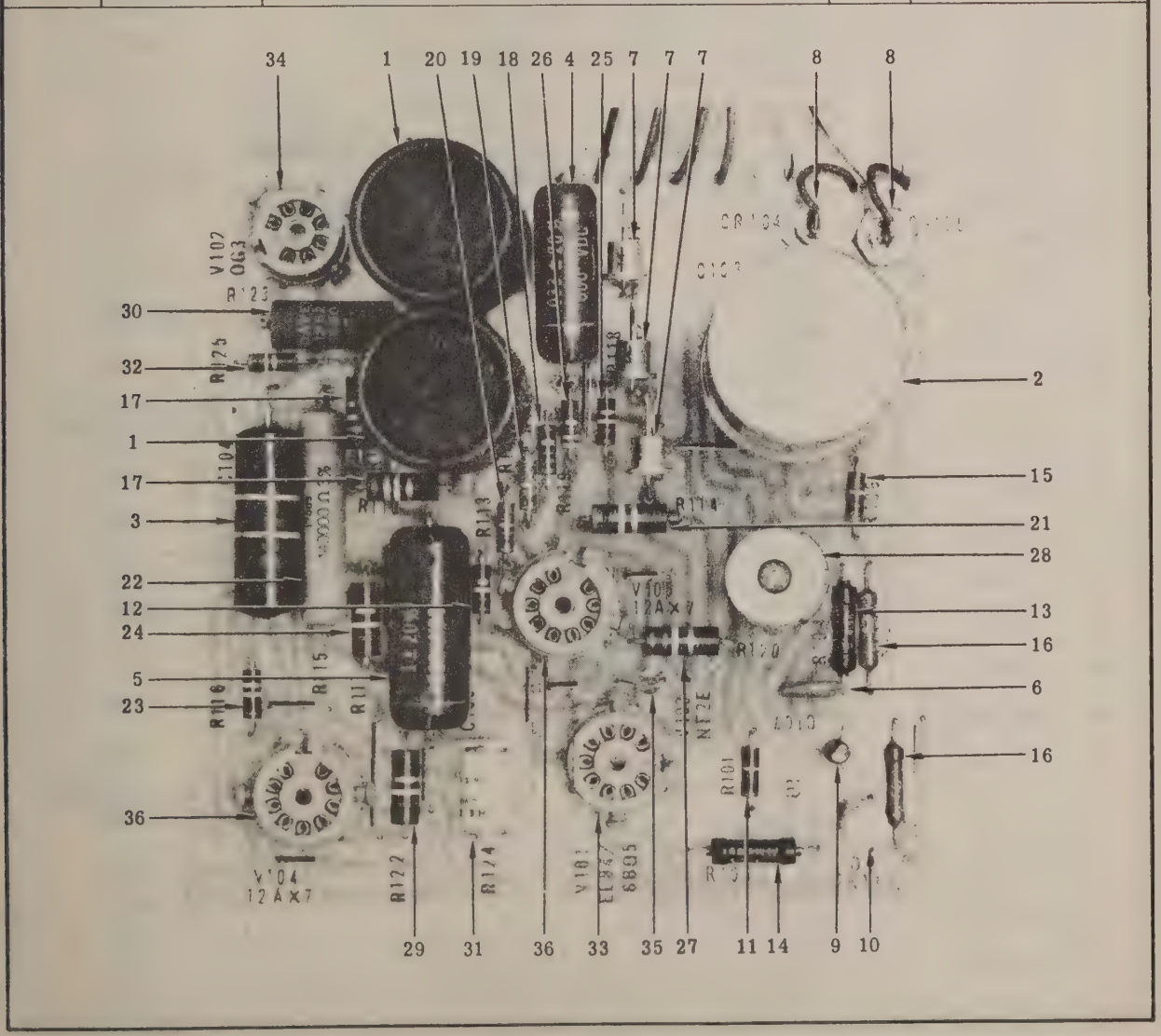


Figure 3-3. Reference Supply Board Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-4-	150029	NULL DETECTOR BOARD ASSEMBLY (see figure 3-1-3 for next higher assembly)	Ref.	
-1	192P10402	. CAPACITOR, plastic, 0.1 uf ±20%, 200V (56289) (106435)	4	C201, C202, C208, C210
-2	600UE473-0-1	. CAPACITOR, plastic, 0.047 uf ±20%, 100V (84411) (106401)	1	C203
-3	600UE474-02	. CAPACITOR, plastic, 0.47 uf ±20%, 200V (84411) (106419)	2	C204, C209
-4	TE1095	. CAPACITOR, electrolytic, 40 uf -10/+100%, 6V (56289) (105205)	1	C205
-5	30GA-D10	. CAPACITOR, ceramic, 0.001 uf ±20%, 3000V (56289) (105635)	1	C206
-6	TE1507	. CAPACITOR, electrolytic, 10 uf -10/+100%, 150V (56289) (106351)	1	C207
-7	663UW-10502	. CAPACITOR, plastic, 1 uf ±20%, 200V (84411) (106450)	1	C211
-8	30D137A1	. CAPACITOR, electrolytic, 200 uf -10/+100%, 6V (56289) (105189)	1	C212
-9	5GA-V75	. CAPACITOR, ceramic, 7.5 uuf ±20%, 1000V (56289) (106849)	1	C213
-10	EZPCB20-20	. CAPACITOR, dual electrolytic, 20/20 uf -10/+50%, 450V (82376) (106247)	1	C214A, C214B
-11	TE1089	. CAPACITOR, electrolytic, 15 uf -10/+150%, 6V (56289) (105700)	1	C215
-12	S6C	. DIODE, silicon, 0.75 amp, 600 PIV (14099) (112383)	1	CR201
-13	2E4	. DIODE, silicon, 1 amp, 100 PIV (81483) (116111)	2	CR202, CR203
-14	C-2701	. CHOPPER, electronic, 60 cycle, SPDT (89743) (103051)	1	G1
-15	EB1051	. RESISTOR, composition, 1 Meg ±10%, 1/2W (04061) (108134)	6	R201, R202, R203 R209, R210, R214
-16	EB3951	. RESISTOR, composition, 3.9 Meg ±10%, 1/2W (04061) (108548)	1	R204
-17	EB2751	. RESISTOR, composition, 2.7 Meg ±10%, 1/2W (04061) (108266)	1	R205
-18	EB4741	. RESISTOR, composition, 470K ±10%, 1/2W (04061) (108290)	1	R206
-19	EB4721	. RESISTOR, composition, 4.7K ±10%, 1/2W (04061) (108381)	1	R207
-20	EB1031	. RESISTOR, composition, 10K ±10%, 1/2W (04061) (108118)	1	R208
-21	EB3341	. RESISTOR, composition, 330K ±10%, 1/2W (04061) (108274)	1	R211
-22	EB1841	. RESISTOR, composition, 180K ±10%, 1/2W (04061) (108431)	1	R212
-23	EB1021	. RESISTOR, composition, 1K ±10%, 1/2W (04061) (108563)	5	R213, R216, R225 R226, R230
-24	EB2731	. RESISTOR, composition, 27K ±10%, 1/2W (04061) (108878)	1	R215
-25	EB1011	. RESISTOR, composition, 100Ω ±10%, 1/2W (04061) (108100)	1	R217
-26	CEC-TO	. RESISTOR, metal film, 90.9Ω ±1%, 1/2W (75042) (151084)	1	R218
-27	Type 110	. RESISTOR, variable, wirewound, 10Ω ±20%, 1-1/4W (71450) (112672)	1	R219

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-4-28	EB3321	. RESISTOR, composition, 3.3K ±10%, 1/2W (04061) (108373)	1	R220
-29	EB2221	. RESISTOR, composition, 2.2K ±10%, 1/2W (04061) (108605)	1	R221
-30	HB4731	. RESISTOR, composition, 47K ±10%, 2W (04061) (110015)	2	R222, R223
-31	EB27G1	. RESISTOR, composition, 2.7Ω ±10%, 1/2W (04061) (108845)	1	R224
-32	Type 110	. RESISTOR, variable, wirewound, 5K ±20%, 1-1/4W (71450) (111609)	1	R227
-33	HB2721	. RESISTOR, composition, 2.7K ±10%, 2W (04061) (110148)	2	R228, R229
-34	NE2E	. LAMP, neon glow, NE2E, 1/10W (89730) (100347)	1	V201
-35	EF86/6267	. ELECTRON TUBE, EF86/6267 (73445) (116715)	1	V202
-36	6AW8A	. ELECTRON TUBE, 6AW8A (49671) (116434) . . .	1	V203
-37	OA2	. ELECTRON TUBE, OA2 (49671) (115873)	1	V204

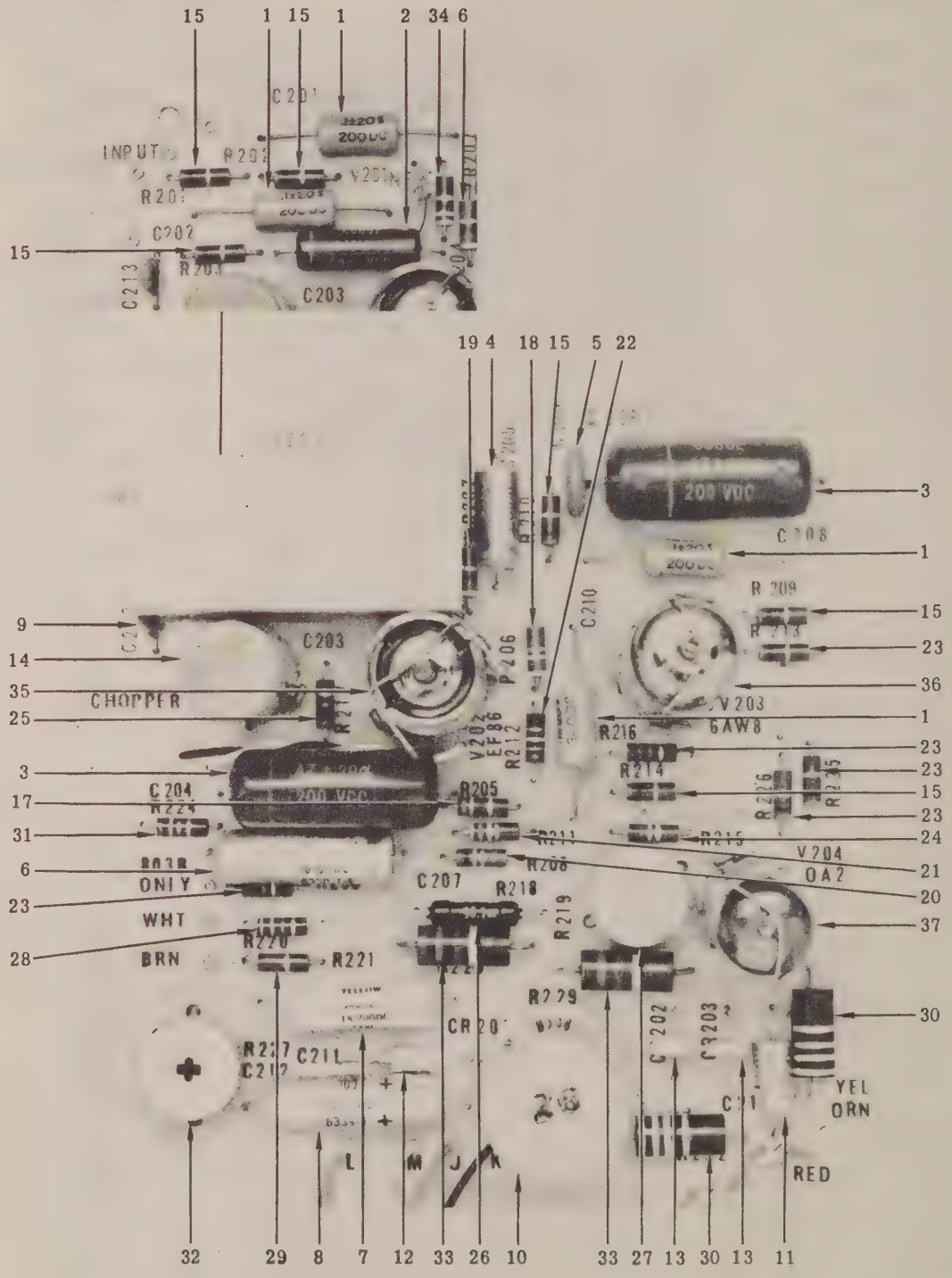


Figure 3-4. Null Detector Board Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-5-	159541	RANGE RESISTOR BOARD ASSEMBLY (see figure 3-1-4 for next higher assembly)	Ref.	
-1	E6-105	. CAPACITOR, plastic, 1 uf ±20%, 600V (99515) (105924)	1	C301
-2	X663UW20502 (2)	. CAPACITOR, plastic, 2 uf ±20%, 200V (84411) (106443)	1	C203
-3	Type C13	. RESISTOR, carbon film, 10 Meg ±10%, 1W (00327) (107748)	4	R301, R302, R303, R304
-4	Type C13	. RESISTOR, carbon film, 9 Meg ±1%, 1W (00327) (107557)	1	R305
-5	Type C12	. RESISTOR, carbon film, 900K ±1%, 1/2W (00327) (107391)	1	R306
-6	Type C12	. RESISTOR, carbon film, 90K ±1%, 1/2W (00327) (107292)	1	R307
-7	Type C12	. RESISTOR, carbon film, 9K ±1%, 1/2W (00327) (107250)	1	R308
-8	Type C12	. RESISTOR, carbon film, 900Ω ±1%, 1/2W (00327) (107771)	1	R309
-9	Type C12	. RESISTOR, carbon film, 100Ω ±1%, 1/2W (00327) (107730)	1	R310
-10	EB2261	. RESISTOR, composition, 22 Meg ±10%, 1/2W (04061) (108233)	5	R311, R312, R313, R314, R315
-11	Type 1180F-PC	. RESISTOR, wirewound, 112.375K ±0.05%, 1W (15909) (112110)	4	R316, R317 R320, R321
-12	Type 110	. RESISTOR, variable wirewound, 1K ±20%, 1-1/4W (71450) (113266)	1	R318
-13	132001	. RESISTOR, wirewound, 459.8Ω ±0.025%, 1/8W (89536)	1	R319
-14	GB2731	. RESISTOR, composition, 27K ±10%, 1W (04061) (109504)	1	R322
-15	Type 110	. RESISTOR, variable, wirewound, 500Ω ±10%, 1-1/4W (71450) (113258)	3	R323, R326, R329
-16	Type 1141	. RESISTOR, wirewound, 28.517K ±0.05%, 1/2W (15909) (112060)	1	R324
-17	Type 1141	. RESISTOR, wirewound, 22.5K ±0.1%, 1/2W (15909) (112045)	1	R325
-18	Type 1141	. RESISTOR, wirewound, 2531.7Ω ±0.05%, 1/2W (15909) (111906)	1	R327
-19	Type 1141	. RESISTOR, wirewound, 24.75K ±0.1%, 1/2W (15909) (112052)	1	R328
-20	Type 1141	. RESISTOR, wirewound, 250.31Ω ±0.05%, 1/2W (15909) (112011)	1	R330
-21	EB2711	. RESISTOR, composition, 270Ω ±10%, 1/2W (04061) (108241)	1	R331

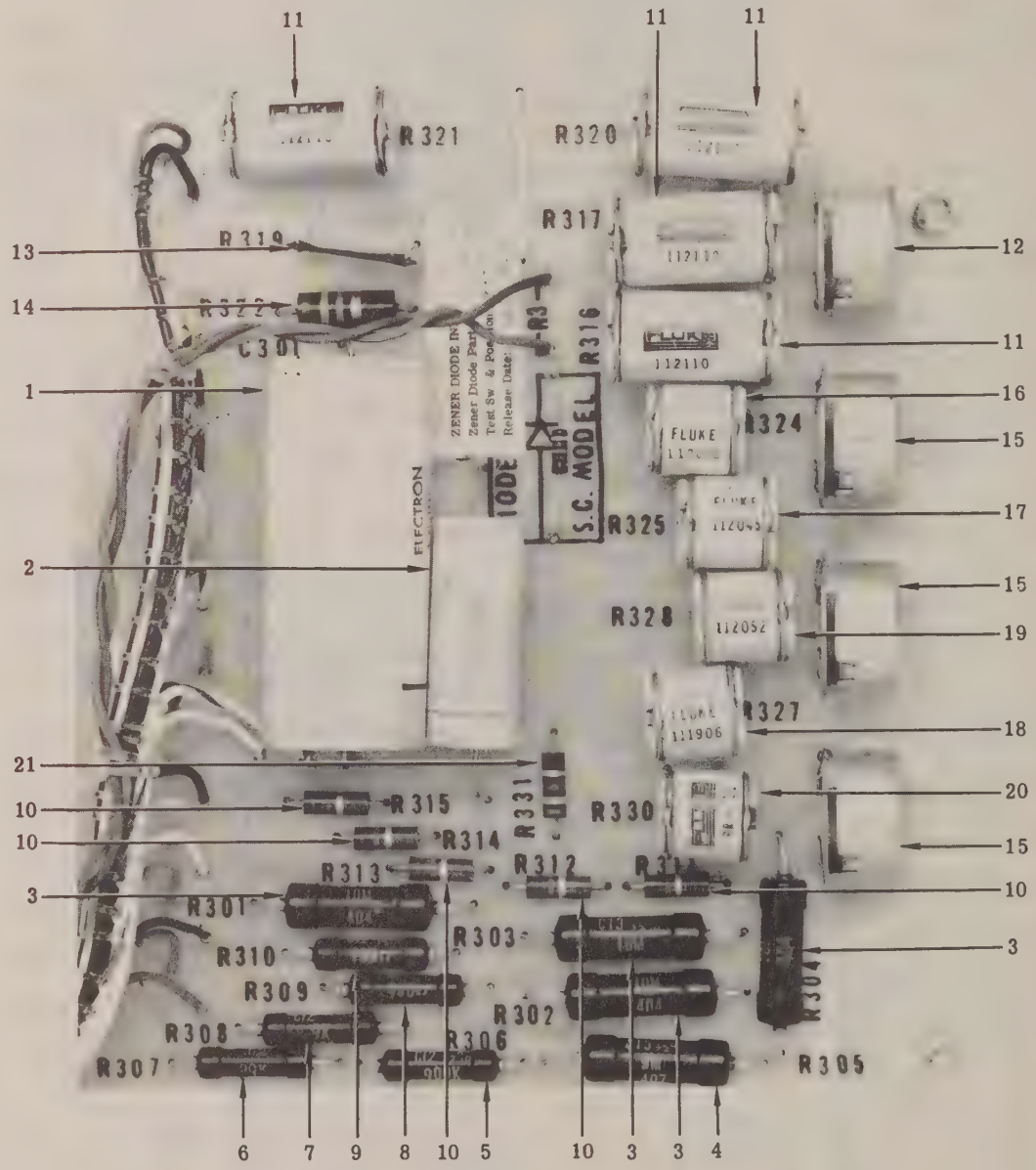


Figure 3-5. Range Resistor Board Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-6-	134775	KELVIN-VARLEY RESISTOR BOARD ASSEMBLY (see figure 3-1-5 for next higher assembly)	Ref.	
-1	146530**	. RESISTOR, wirewound, 40K ±0.02%, 1/2W (89536)	6	R401 thru R406
-2	131946**	. RESISTOR, wirewound, 8K ±0.005%, 1/2W (89536)	11	R407 thru R417
-3	131953**	. RESISTOR, wirewound, 1.6K ±0.01%, 1/8W (89536)	11	R418 thru R428
-4	146159	. RESISTOR, wirewound, 320Ω ±0.02%, 1/8W (89536)	11	R429 thru R439
-5	146167	. RESISTOR, wirewound, 64Ω ±0.1%, 1/8W (89536)	10	R440 thru R449

**These resistors are factory matched for each instrument. When ordering, specify instrument model and serial number and all information stamped on resistor.

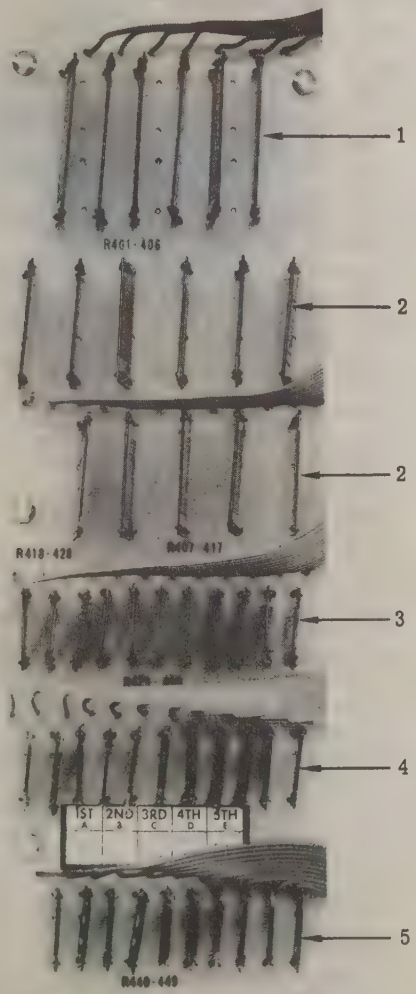


Figure 3-6. Kelvin-Varley Resistor Board Assembly

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-7-	120527	CONVERTER/AC RANGE SWITCH ASSEMBLY (see figure 3-1-6 for next higher assembly)	Ref.	
-1	S9G	. DIODE, silicon, 60 ma, 40 PIV (03877) (112359) .	2	CR501, CR502
-2	120535	. CONVERTER ASSEMBLY (89536)	1	
-3	D29221	. . CAPACITOR, electrolytic, 10-10 uf -10/+50%, 500V (56289) (105130)	1	C505A, C505B
-4	DD502	. . CAPACITOR, ceramic, 0.005 uf ±20%, 500V (04061) (105650)	1	C506
-5	BB603U1KW7W	. . CAPACITOR, ceramic, 300 uf ±10%, 500V (71590) (105734)	1	C507
-6	600UE47402	. . . CAPACITOR, plastic, 0.47 uf ±20%, 200V (84411) (106419)	2	C508, C511
-7	Type 600UE	. . CAPACITOR, plastic, 0.0068 uf ±20%, 400V (84411) (106591)	1	C509
-8	30GA-D10	. . CAPACITOR, ceramic, 0.001 uf ±20%, 3000V (56289) (105635)	1	C510
-9	67P10404	. . CAPACITOR, paper, 0.1 uf ±20%, 400V (56289) (105312)	1	C512
-10	30D198A1	. . CAPACITOR, electrolytic, 20 uf -10/+100%, 50V (56289) (106229)	1	C513
-11	UK225	. . CAPACITOR, ceramic, 2.2 uf -0%, 3V (71590) (106393)	1	C514
-12	X663UW-20502	. . CAPACITOR, plastic, 2 uf ±20%, 200V (84411) (106443)	2	C515, C518
-13	E6-105	. . CAPACITOR, paper, 1 uf ±20%, 600V (99515) (105924)	1	C516
-14	D2-505D	. . CAPACITOR, plastic, 5 uf ±5%, 200V (99515) (106997)	1	C517
-15	30D120A1	. . CAPACITOR, electrolytic, 500 uf -10/+100%, 3V (56289) (106328)	1	C522
-16	2E4	. . DIODE, silicon, 1 amp, 100 PIV (81483) (116111)	1	CR503
-17	Type C42S	. . RESISTOR, metal film, 68K ±5%, 2W (07115) (111112)	2	R506, R507
-18	Type C42S	. . RESISTOR, metal film, 56K ±5%, 2W (07115) (111104)	1	R508
-19	Type LP1-5	. . RESISTOR, metal film, 100K ±5%, 5W (07115) (111195)	1	R509
-20	EB3321	. . RESISTOR, composition, 3.3K ±10%, 1/2W (04061) (108373)	2	R510, R511
-21	EB2211	. . RESISTOR, composition, 220Ω ±10%, 1/2W (04061) (108191)	2	R512, R531
-22	EB2711	. . RESISTOR, composition, 270Ω ±10%, 1/2W (04061) (108241)	1	R513
-23	EB1851	. . RESISTOR, composition, 1.8 Meg ±10%, 1/2W (04061) (108720)	2	R514, R518
-24	EB2251	. . RESISTOR, composition, 2.2 Meg ±10%, 1/2W (04061) (108225)	1	R515
-25	EB1561	. . RESISTOR, composition, 15 Meg ±10%, 1/2W (04061) (108647)	1	R516
-26	EB1861	. . RESISTOR, composition, 18 Meg ±10%, 1/2W (04061) (108985)	1	R517
-27	EB4701	. . RESISTOR, composition, 47Ω ±10%, 1/2W (04061) (108688)	2	R519, R527
-28	Type C42S	. . RESISTOR, metal film, 120K ±5%, 2W (07115) (111120)	1	R520
-29	EB1811	. . RESISTOR, composition, 180Ω ±10%, 1/2W (04061) (108571)	1	R521
-30	EB1031	. . RESISTOR, composition, 10K ±10%, 1/2W (04061) (108118)	1	R522

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-7-31	EB3911	. . RESISTOR, composition, 390Ω ±10%, 1/2W (04061) (108365)	1	R523
-32	EB3341	. . RESISTOR, composition, 330K ±10%, 1/2W (04061) (108274)	1	R524
-33	EB4741	. . RESISTOR, composition, 470K ±10%, 1/2W (04061) (108290)	2	R525, R532
-34	EB2241	. . RESISTOR, composition, 220K ±10%, 1/2W (04061) (108217)	1	R526
-35	Type C42S	. . RESISTOR, metal film, 150K ±5%, 2W (07115) (111138)	1	R528
-36	GB1041	. . RESISTOR, composition, 100K ±10%, 1W (04061) (109397)	1	R529
-37	Type LP1-15	. . RESISTOR, metal film, 47K ±5%, 5W (07115) (111187)	1	R530
-38	Type 110	. . RESISTOR, variable, wirewound, 500Ω ±10% 1-1/4W (71450) (112433)	1	R536
-39	Type C12	. . . RESISTOR, deposited carbon, 100K ±1%, 1/2W (00327) (107185)	1	R537
-40	Type 1141	. . RESISTOR, wirewound, 21.28K ±0.1%, 1/2W (15909) (113217)	1	R538
-41	Type R1136	. . RESISTOR, wirewound, 490Ω ±0.1%, 1/2W (15909) (112805)	1	R539
-42	6EJ7-EF184	. . ELECTRON TUBE, 6EJ7 (73445) (116699).	1	V501
-43	6AW8A	. . ELECTRON TUBE, 6AW8A (49671) (116434)	1	V502
-44	120543	. AC RANGE SWITCH ASSEMBLY (89536)	1	
-45	VCJ1014	. . CAPACITOR, variable, air, 0.8 to 4.5 uf, 500V (73899) (105023)	4	C501, C504, C519, C523
-46	TU20200KCOG	. . CAPACITOR, ceramic, 20 uuf ±20%, 600V (71590) (105619)	1	C502
-47	63UW124S6W	. . CAPACITOR, plastic, 0.12 uf ±5%, 600V (84411) (107003)	1	C503
-48	TCZ-3R3	. . CAPACITOR, ceramic, 3.3 uf ±20%, 600V (71590) (106583)	1	C520
-49	TCZ-82	. . CAPACITOR, ceramic, 82 uuf ±2%, 600V (71590) (105940)	2	C521, C525
-50	TU45301KCOG	. . CAPACITOR, ceramic, 300 uuf ±5%, 600V (71590) (105601)	1	C524
-51	Type DA2	. . RESISTOR, metal film, 1 Meg ±1%, 1/2W (15909) (111146)	1	R501
-52	Type DA2	. . RESISTOR, metal film, 122K ±1%, 1/2W (15909) (111260)	1	R502
-53	Type 110	. . RESISTOR, variable, wirewound, 6K ±5%, 1-1/4W (71450) (113209)	1	R503
-54	Type DA2	. . RESISTOR, metal film, 1 Meg ±0.5%, 1/2W (15909) (111252)	1	R504
-55	EB4701	. . RESISTOR, composition, 47Ω ±10%, 1/2W (04061) (108688)	1	R505
-56	Type DA2	. . RESISTOR, metal film, 500K ±1%, 1/2W (15909) (111153)	2	R533, R543
-57	Type 110	. . RESISTOR, variable, wirewound, 300Ω ±20%, 1-1/4W (71450) (112870)	1	R534
-58	Type 1137	. . RESISTOR, wirewound, 10.05K ±0.1%, 1/2W (15909) (112813)	1	R535
-59	Type DA2	. . RESISTOR, metal film, 500K ±0.5%, 1/2W (15909) (11245)	1	R540
-60	275-1-202	. . RESISTOR, variable wirewound, 2K ±10%, 1/4W (80294) (113191)	1	R541

FIG. & INDEX NO.	PART NO.	DESCRIPTION 1 2 3 4 5 6 7	QTY. PER ASSY.	REFERENCE DESIGNATION
3-7-61	Type DA2	. . RESISTOR, metal film, 48.75K ±1%, 1/2W (15909) (111443)	1	R542
-62	EB3941	. . RESISTOR, composition, 390K ±10%, 1/2W (04061) (108993)	1	R544
-63	120683	. . SWITCH, range, ac section (89536)	1	S2

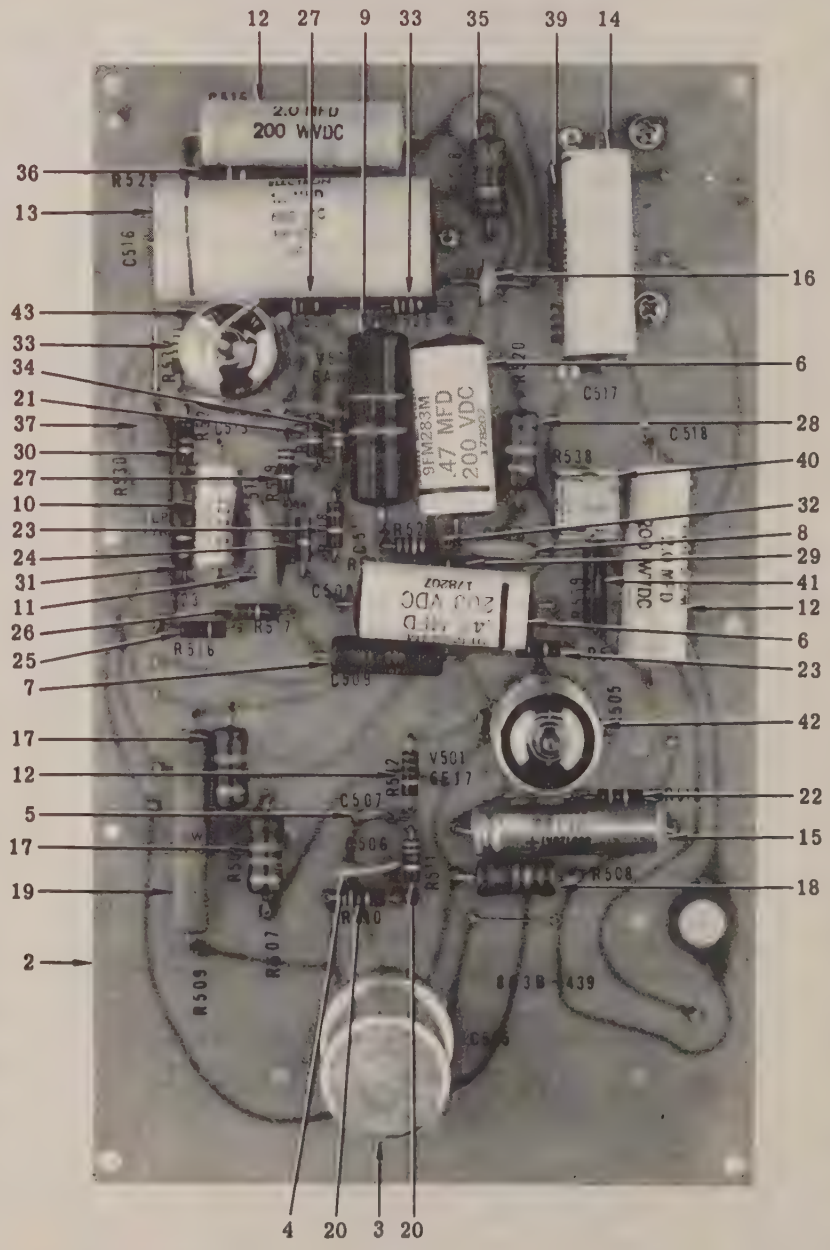


Figure 3-7. Converter/AC Range Switch Assembly (Sheet 1 of 2)

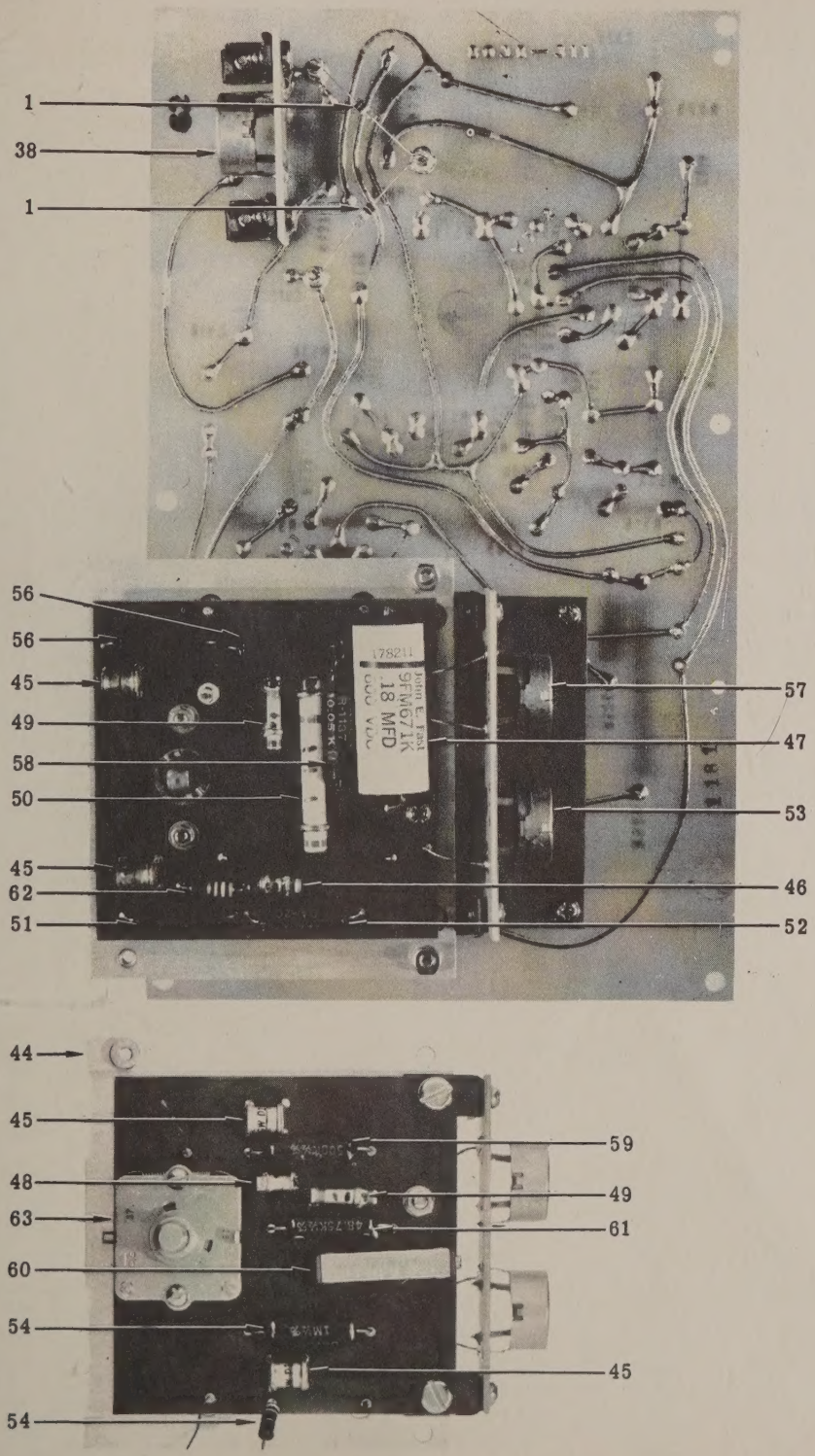
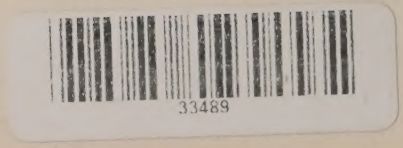


Figure 3-7. Converter/AC Range Switch Assembly (Sheet 2 of 2)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